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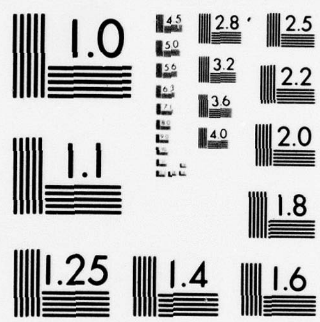

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THESIS

LOGISTICS MANAGEMENT—
DESIGN AND APPLICATION

by

Sjur W. Knudsen

December 1978

Thesis Advisors: J. W. Creighton
R. W. Sagehorn

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Logistics management is a comprehensive term covering the method by which one attempts to see as a single unit the materials flow to, inside, and from the company.

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In the broadest sense, logistics management views a company as a single operating system; it seeks to minimize total costs associated with the acquisition and handling of materials from the inception of materials requirements to the final delivery of finished products to their users. Logistics management can therefore be defined as the planning, organizing, and controlling of all move-store activities that facilitate product flow from the point of raw material acquisition to the point of final consumption, and of the attendant information flows, for the purpose of providing a sufficient level of customer service (and associated revenues) consistent with the costs incurred for overcoming the resistance of time and space in providing the service [1;8].

The successful management of logistics in an organization requires the careful coordination and manipulation of both movement and storage.

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Logistics Management—Design and Application

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

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December 1978

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ABSTRACT

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The successful management of logistics in an organization requires the careful coordination and manipulation of both movement and storage.

PREFACE

Logistics is a relatively new field of study in management. The concept of logistics first took hold in the early 1960's and has developed rapidly since then. The newness of the field lies in the approach used to manage various subfunctions such as traffic, transportation, inventory management, warehousing, packaging, order processing and materials handling. The new aspect is the systems approach, which recognizes the interrelationships among the traditional functions of logistics and other areas of management. Logistics is no longer regarded in a negative context, but rather as a productive functional area that can be managed to increase the profitability of a company.

Logistics management, which is a combination of materials management and physical distribution management, stands at the threshold of being recognized as the "third" functional area of business.

The purpose of this thesis is to provide a relatively comprehensive and up-to-date study of logistics management, since this field is of growing importance and has not yet been given sufficient attention.

This thesis is written about the management of logistics activities in private business/industry with implications about the management of logistics activities in such areas as the military, service organizations, and non-profit institutions.

The systems approach which is used as a basis for the design of logistics management systems is applicable to any type of organization with several logistics activities.

This thesis may contain some overlaps due to the extensive collection/development of information about logistics management. To make the content more natural and easier to understand, the thesis is mainly expressed in we-form instead of the third person.

Chapter I explains the concept of logistics management, while Chapter II focuses on the design of logistics management systems, and finally chapter III delves into the development of such systems.

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I. LOGISTICS MANAGEMENT

A. INTRODUCTION

Business regards the matter of logistics management (LM) as important, but remains somewhat confused as to its meaning and how it should be implemented.

LM is often defined as another function in the firm. LM should not be thought of as a function, but as a way of thinking about problems. It involves a systems view of the entire materials flow process.

In this chapter the concept of LM is examined historically, basically, and within the framework of system theory.

B. HISTORICAL USAGE

Logistics has long been used as a military term. The roots of the word can be traced to the Latin LOGUGEA, meaning "lodge" or "hut," and later to the French verb, LOGER, which means to "lodge." The first recorded use of logistics in a military organization was the creation of the position of Marechal General des Logis by the French army in 1670. This officer was responsible for selecting campsites, planning marches, and regulating transportation and supply [2].

Through the years, as military strategy and equipment changed, so did the duties of logisticians. For instance, mammoth logistical problems were posed by global conflict during World War II, and postwar power struggles reaffirmed

the constant need for highly mobile forces capable of immediate deployment to any location in the world. By solving the problems associated with these complex needs, the modern concept of military logistics was formulated.

In 1951, Oscar Morgenstern, a well known mathematician, affirmed that "there is an immediate similarity between military logistics and the logistical problems that have to be solved daily in business."

While business firms were preoccupied with a technique oriented and later functionally oriented concept of logistics, military use of the term underwent an important change. With the adoption of the Planning-Programming-Budgeting System (PPBS) during the 1960's, the Department of Defense in the United States was forced to evaluate programs or weapons systems on the basis of performance over the entire life cycle of the project. Consequently, a system theory was needed for material support problems, and logistics has come to mean a way to solve such problems. Although few firms have installed their own PPBS, such a basic system theory is necessary for the appropriate application of logistics in the firm. As a matter of fact, unfamiliarity with general systems theory is no doubt a major reason why the logistics concept is often misapplied by business when it attempts to organize for it.

During the past 15 years, business adopted the term "logistics" and used it extensively. Several firms have conducted studies of their logistics system; some have even organized departments charged with planning and control

responsibility in the area. There remains, however, a large number of firms whose management remains confused over how best to implement logistics, whatever it is supposed to mean.

Many managers can draw upon their military experience for a definition. Others hear that logistics means having a physical distribution function at a high level in the firm. Some believe that logistics means good materials management. What then should this concept mean to the businessman, and how should he make logistics work for him?

C. WHAT IS LOGISTICS MANAGEMENT?

Logistics management (LM) is a comprehensive term covering the method by which one attempts to see as a single unit the materials flow to, inside and from the company. We make use of integrated decision making and modern business aids such as, for example, operations research and automatic data processing. This means in most cases that we assemble under a single manager various organizational units which are directly affected by the flow of materials. LM can therefore be defined as the method and principles by which we endeavor to plan, organize, coordinate, control and review the flow of materials from the raw material supplier to the final user. Logistics control is defined as a subordinate concept and covers the attempt to improve the attainment of objectives with given resources in a given logistics system (materials system).

The term materials administration (MA) is sometimes used to denote the concept here called logistics management, that

is the integrated control and physical movement of materials and products from the raw material supplier via stores, processing and warehouse to the final user. Among the benefits of applied logistics management are:

* improved distribution control
* improved inventory management
* decreased purchasing cost
* more effective communication paths
* better supplier/customer cooperation

D. THE LOGISTICS SYSTEM

To understand the basis of a logistics system we must start here and examine a very simplified materials flow system which is made up only of supplier, warehouse (stocks) and buyer.

SUPPLIER → WAREHOUSE (STOCKS) → CUSTOMER

Figure 1. A simplified materials chain [4;27]

Between the components, a flow of materials and products passes from the supplier to the warehouse and from the warehouse to the customer.

In this system a supply function and a distribution function are completed. But for the system to function at all, impulses are needed which start up activities and see to it that they run correctly. To set the dispatch sequence in motion, it is necessary to have an order which goes to a

decision point; from there a control impulse passes to the warehouse and sets on foot the dispatch of the product. This is the basic operation of the system and it functions smoothly provided there is something to send from the warehouse.

We are therefore dependent on the warehouse not becoming empty and we must at certain times send a requisition from the warehouse via a decision point to the suppliers to initiate a delivery to refill the warehouse stock. In this case we are concerned with a purely physical decision on the stock level, and as seen from Figure 2 we therefore have a materials flow on which we have imposed an information flow in order that the operations can be carried out.

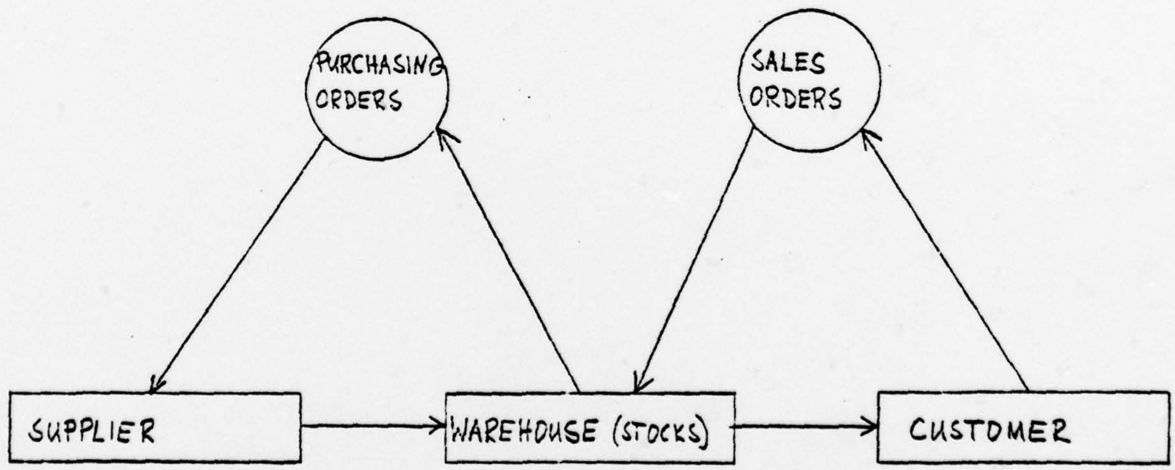

Figure 2. The simplified chain in Fig. 1 completed by an information flow [4;27]

The information called for at the distribution point (order reception) to ensure that the materials flow system functions when orders are received, comprises details of whom the goods shall be shipped to, the quantity to be sent, the quality or type of goods concerned and the price to be applied. In addition we must, at the purchasing decision point, know of possible suppliers or otherwise we cannot place the order. Therefore, information is required about the external environment to make even this simple system function efficiently.

It is not sufficient only to sell products. We must also market them, that is, we must investigate the market and its changes in requirements, and adapt ourselves to them. At the same time as we adapt ourselves to the market, we must try to influence it. All this calls for a well planned and efficiently functioning system for the collection and processing of data.

At the opposite point in the internal logistics system, a corresponding system is needed for purchasing operations, where we assemble data on the supplies market, negotiate and place purchasing orders.

The information system in Figure 2 is built, as already pointed out, on a purely physical inventory which of course can be quite difficult to carry out if we add another function, a registration function. We retain supplier, stock and customer, but at the same time as the order comes in and serves as a control impulse to the warehouse, we arrange for a copy of

the order to go to a function which we may call stock records, where we have a purely stockbook check of stocks (Figure 3). An entry is made in the stocks records that a product has been taken out of stock and this may mean that we must order new goods.

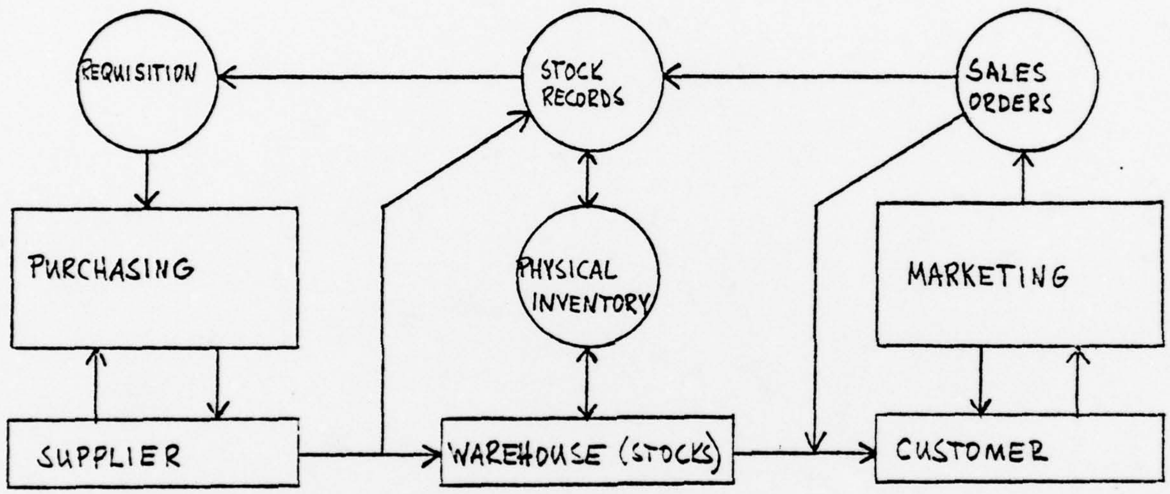

Figure 3. Figure 2 completed by stock records and market contacts. In principle, this system can function without coordination, but if complications arise, a coordinating unit is required as well [4;29]

From time to time we must carry out a reconciliation and check the stock record against the physical stock in the warehouse. When the stock record shows that the order point has been reached, a purchasing order is sent out which proceeds via the decision point to the supplier. The result is a delivery which is registered both in the stores and in the stock records.

The complexity increases if we add a further function to the previously much simplified picture of the materials flow. Broadly speaking, we are concerned here with the same system as previously. The difference is that we added a subsystem, the manufacturing system. We now have a complete system with materials flow and information flow, which is sufficient for the system to function, though the demand for coordination is strengthened if the company is working in a strongly competitive field. This leads us to Figure 4, which shows how the various subsystems are integrated via decision points right up to total integration at top level.

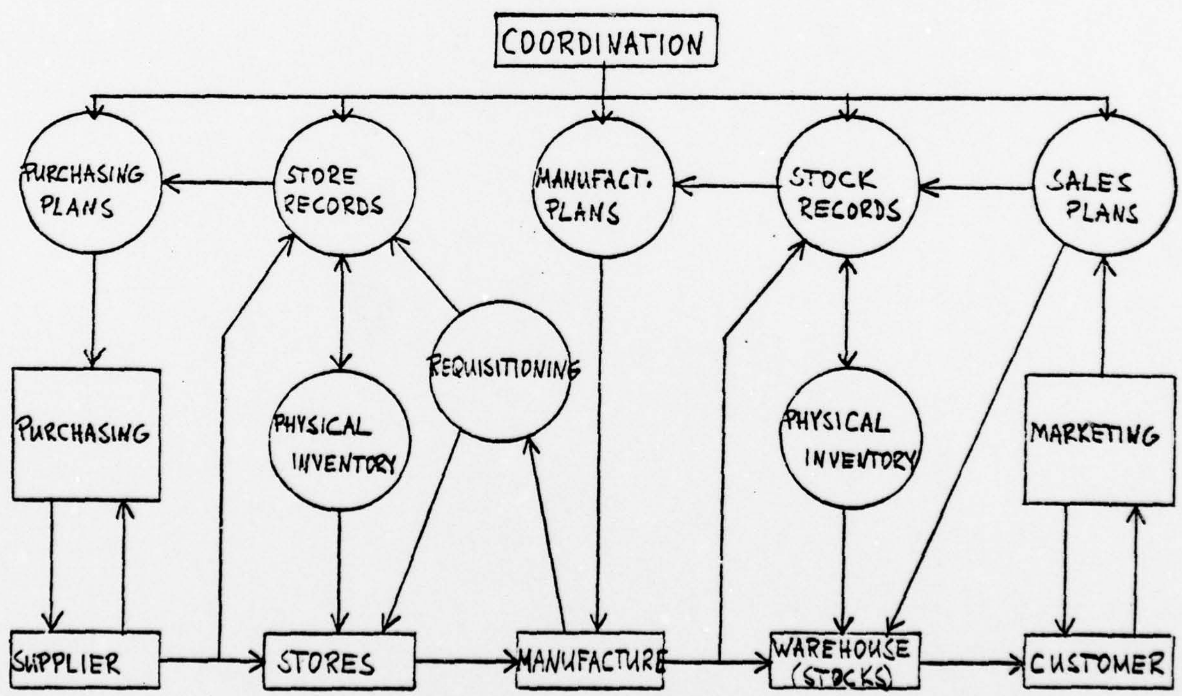

Figure 4. Subsystems from Figs. 2, 3 integrated and completed by the manufacturing system [4;30].

What we have used throughout in this system is in detail, what could be called operational information, and this is provided to enable the subsystems to function at operational level.

To improve efficiency in the materials flow still further, it may be useful to give the decision points more tasks to perform. They can gather information from outside and, for example, group the orders into appropriate delivery quantities. Similarly on the corresponding side, we group purchasing orders or requisitions into suitable quantities before they are passed on to various suppliers.

The decision points should initiate certain tasks in addition to the ones outlined above. These are to work out plans and to influence the environment, that is customers or suppliers as the case may be, in order to obtain the best possible terms. We are then working with tactical information and tactical decision too.

In Figure 4 the materials flow is illustrated from the suppliers via the stores, processing and finished stock on to the various customers. The stock is the amount we have of finished products ready for dispatch, whereas the stores are materials, components, semifabricated goods which we ourselves must use. Figure 4 shows that, just as before, there is an incoming impulse—the order—which goes to a decision point (the sales department). From there an impulse goes on to the stock records and to the warehouse where we make ready and dispatch the goods. From the stock records, assuming we have

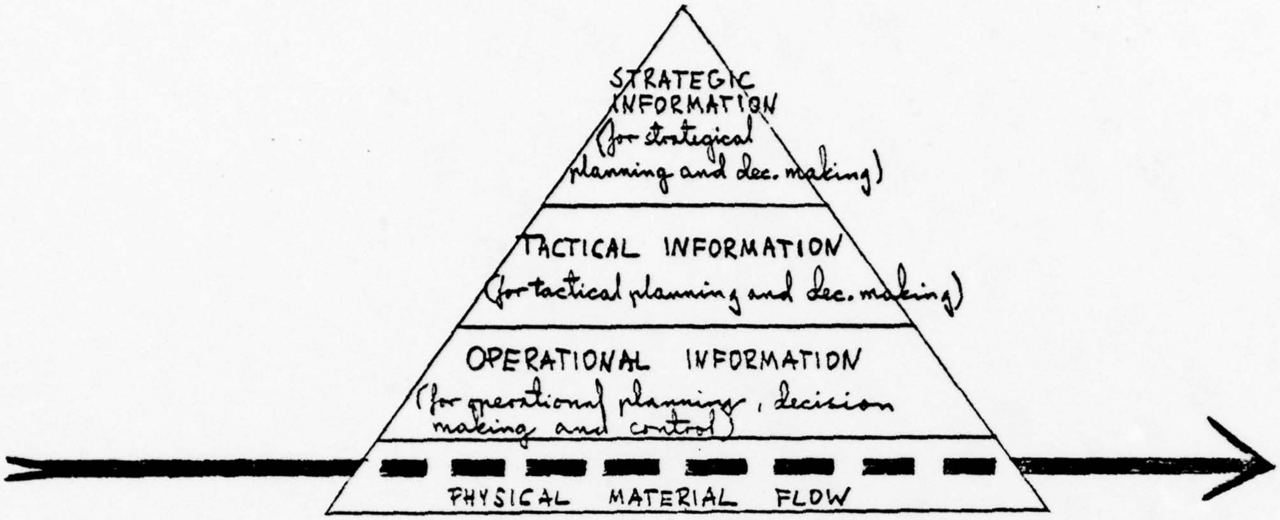

Figure 5. Materials flow and different types/levels of information.

By our demand for total control and increased coordination in the company, we are faced with other problems. This coordination requires total objectives and we must also obtain and keep up the information which is called for.

E. THE DEVELOPMENT OF THE TERM LOGISTICS MANAGEMENT

The American concepts of materials management (MM), physical distribution management (PDM) and logistics management (LM) are continually being broadened and thus become increasingly similar.

To begin with, the term MM mainly covered the inflow of materials forward to the production apparatus. The concept was therefore most suited to industrial companies.

The term PDM at the beginning chiefly covered the outflow of finished goods for distribution to the final user. To a

great extent we are here concerned with external transport, our own distribution warehouses, and collaboration with different types of intermediaries.

LM was at first related to internal distribution, for example, of spare parts for storage and handling at suitable bases to keep a transport fleet at work in a correct way. This springs quite naturally from the origin of the concepts of logistics. It arises from military practice, and is primarily concerned with keeping troops supplied with materials and necessities. The concept was developed further in close connection with different aspects of transport problems, for example, combinations of means of transport and the proper balancing of transport with stockholding.

The Norwegian concept of logistics management, often called materials administration (MA), embraces both inflows and outflows as well as the internal flows. The American concepts continue to extend and the term LM is beginning to resemble the Norwegian concept of LM more and more. To a great extent, this development has been a purely "practical" process, which emerged in progressive companies with the "theoretical" frame of reference lagging somewhat behind.

Today the terms discussed above can be defined and expressed in total picture of a firm's logistics system like this:

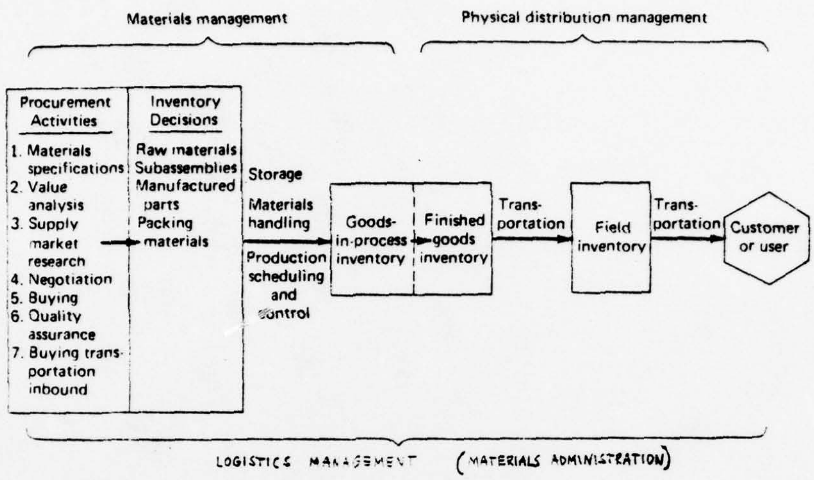

Figure 6. System management concepts imposed on the flow of materials and related activities in a firm's logistics system [3;25].

F. GENERAL SYSTEMS THEORY

General systems theory provides a challenging institutional framework for logistics development in non-military and non-defense enterprises. The theory has gained wide acceptance as a way of studying a variety of human organizations as complete systems.

The traditional functional view of organizations isolates physical mechanisms, material components, psychosocial effects, political legal elements, economic constructs, and environmental constraints. Traditionally, each of these elements was optimized, often ignoring the interrelationship among them. But as organizations developed, complex interdependencies evolved, and a holistic approach became necessary to cope with the problems of the organization.

System theory asserts that the organization can maintain a dynamic equilibrium by importing resources such as raw materials, energy and information; subjecting all these to a transformation process; and exporting goods and services back into its environment. Thus, the system has inputs, a process and outputs. Any changes in the import process must be carried through the transformation and export process as well. Thus, purchasing raw materials in greater bulk to gain the economies of a price break cannot be considered in isolation. Inventory carrying costs, transportation charges, and product demand must be incorporated into the decision process so that the total costs and benefits of the alternatives can be determined.

Central to total systems theory is the idea that firms will no longer have as their objective the optimization of individual functions such as manufacturing and procurement. Instead, functional elements will be suboptimized in favor of optimizing the complete system, either by maximizing total profit or minimizing total costs. The organization is therefore regarded as an entity, acting and interacting with its environment, and maintaining a dynamic equilibrium through the synergistic efforts of subsystem components.

The discussion in the previous section about a simplified logistics system concerns the whole flow of materials from supplier of raw material to final user:

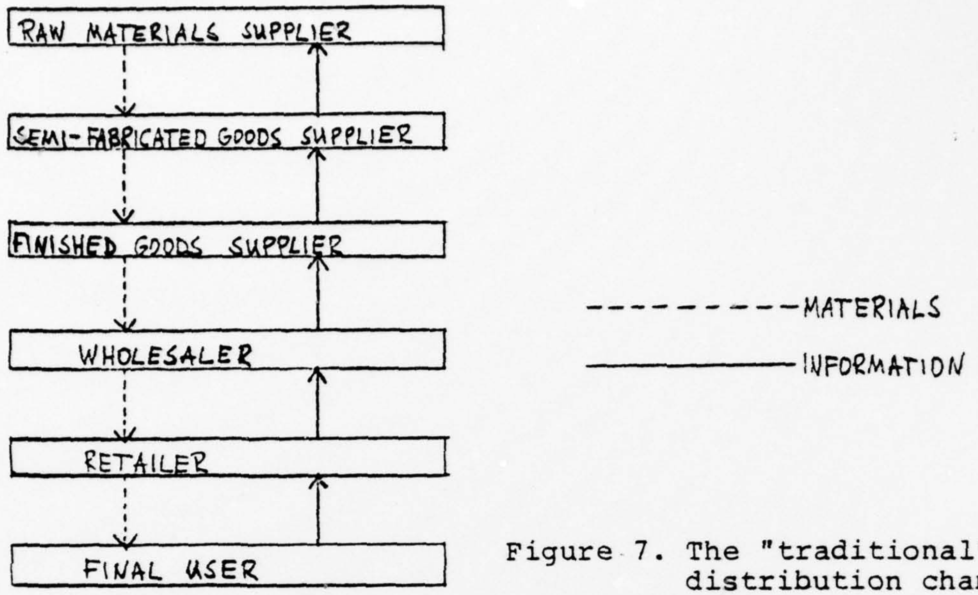

Figure 7. The "traditional" distribution channel.

For the whole distribution to be regarded as an internal system, however, it must lie under common management. In most cases this does not happen; the distribution channel comes to be regarded as a "mixed system" since products are presented and distributed via a long chain of companies.

The chain shown in Figure 7 should be understood as a chain of functions rather than a chain of companies. With the starting point we have adopted, such an analysis of functions is more rewarding then an institutional analysis. We are interested in the functional aspects of the operations which are carried out in the complete chain and not in the institutional aspects.

G. A LOGISTICS SYSTEM CONCEPT

As previously defined, LM basically involves controlling, organizing, staffing, directing, coordinating, and planning

product flow from the point of procurement to the ultimate consumer (or user). More specifically, the logistics activities of a business entity can be divided into nine areas:

1) procurement
2) inventory control
3) material handling
4) warehousing, packaging and containerization
5) scheduling and allocation
6) order processing
7) site determination
8) customer service
9) transportation

In effect, these nine activities constitute the principal components of a micro-logistics system.

Figure 8 schematically reflects the micro-features of a modern LM system. The diagram depicts how raw materials "flow" through the eight logistics components with transportation the ninth element, and communications forming the common bond. Product flow is planned, directed, organized, and controlled from the point of procurement to the point of final sale. The absolute parameters to the illustrated system are the economic and legal external environments within which the firm operates. Managerial decision making, given this micro perspective, should focus upon overall logistics objectives, not upon any single components of the LM system.

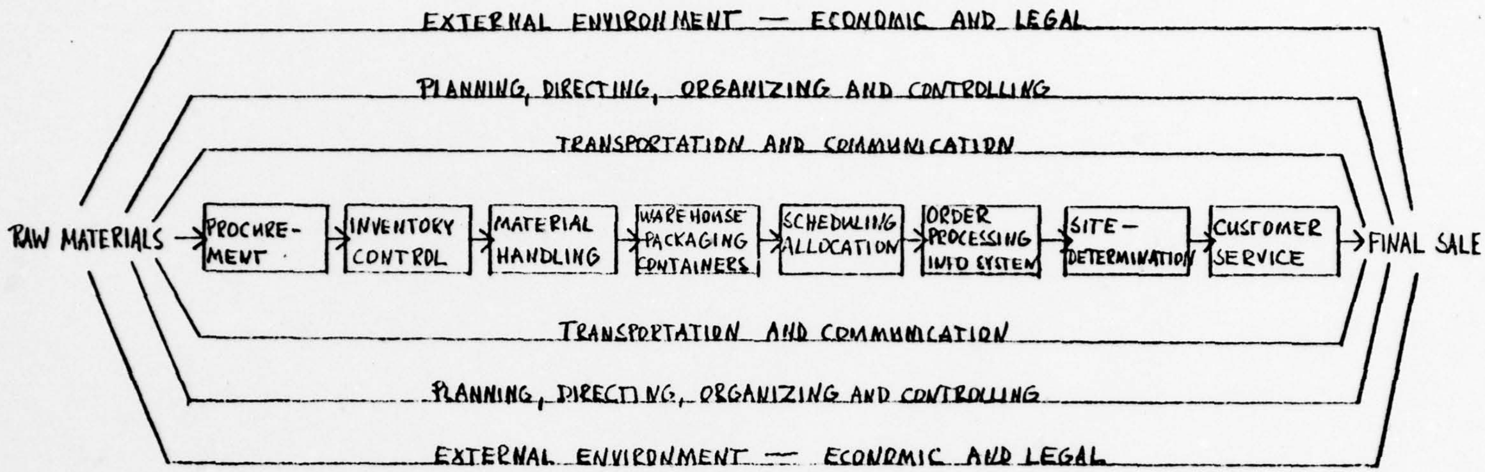

Figure 8. Overview of a micro-logistics system [1;12].

Logistics systems, being one of the major subsystems of a business entity, are the system that create time and place utility in products. It can also be conceived as the total materials and product flow process. Logistics systems are therefore both a subsystem and a system in its own right. The former holds because logistics is only one part of the total organization; the latter holds because logistics is composed of a number of subsystems (such as transport and storage), each a part of the total flow process. Below is shown a total logistics system focused upon the material and information flow from a micro point of view:

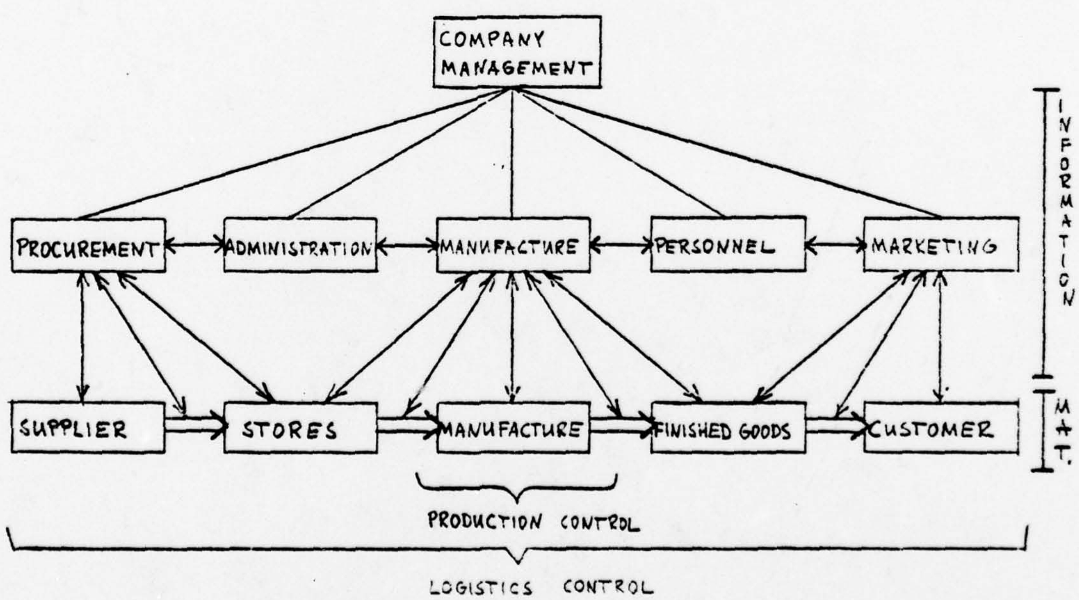

Figure 9. The logistics system from a micro point of view [4;162].

Current conceptions of logistics in the organization are often related to specific functional interests. Marketing people tend to see logistics primarily as it affects customer service. Transportation personnel often view logistics as covering those functions performed by a good traffic manager. The engineering profession sees logistics primarily as a technical product design and maintenance function. When people from varying backgrounds join to try to implement logistics, they find, more often than not, that they are talking about substantially different topics. Communication is difficult because of the lack of a common theoretical base from which a mutually acceptable concept of LM can be developed for implementation in the organization.

System theory provides such a needed base because it permits logistics considerations to extend across the artificial barriers of organized functions. Procurement, warehousing, traffic and order processing must work in concert, according to system theory, just as the heart, lungs and nervous system must work together to sustain human life. Individual elements can be made to function better, but it is not until all elements are coordinated that the potential of the entire system can be tapped.

Because LM is primarily concerned with controlling the flow of materials and products, the development of an effective organizational structure is important. Indeed, if managerial responsibility for product flow is divided and allocated

among several departments, then a difficulty will be encountered with respect to coordinating the movement of the goods.

Unless interdepartmental coordination is provided for through the medium of a responsive organizational form, the task of achieving overall logistics goals and objectives will be formidable. For example, customer service requirements may dictate maintaining a low level of finished goods inventory whereas production considerations may suggest otherwise. The company may select to take the advantage of lower production costs gleaned from manufacturing a larger number of finished goods. However, such action on the part of the firm would be inappropriate if aggregate objectives demand that a small finished goods inventory be maintained.

To avoid controversies involving the work functions of logistics, the firm should be so organized and managed that this type of basic incompatibility of goals will be reconciled in the interest of the lowest total cost of the system.

As mentioned earlier, a logistics system consists of the flow of goods through a business enterprise. As such, the organizational structure should reflect this flow. Figures 10 and 11 illustrate dichotomous views of product flow within the firm. In Figure 10, procurement, material handling, raw material inventory, inbound transportation, and raw materials warehousing are coordinated and converted into outputs through the medium of LM and operation. On the other hand, Figure 11 depicts the LM function and role as it is generally perceived, that is the work functions of LM are employed in such a manner that product flow is assisted and not hindered.

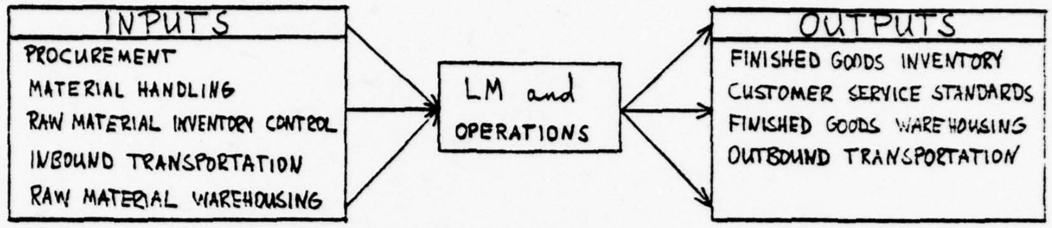

Figure 10. Flow of inputs and outputs of an industrial logistical system [1;27].

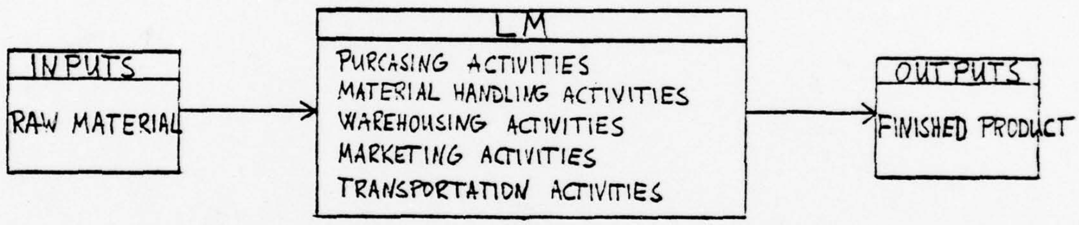

Figure 11. Material flow through typical LM-system [1;27].

There is no doubt whatever that improved control and review of the materials flow should be able to contribute significantly to increased profitability. However, to use LM efficiently it is necessary

* that management accepts the approach and works actively for its implementation, even though this may involve some organizational changes;

* that the objectives, goals and policies in the company are clearly defined;
* that we have access to persons who can impose a system-analytical approach on the organization and apply any operations research and data processing techniques which appear useful;
* that cost items, especially those connected with the logistics system, be set out and accurately posted. Many of the accounting systems now in use are unfortunately unsuitable from this point of view.

If these fundamental demands are met, the practical work can begin.

H. REVIEW

In the broadest sense, LM views a firm as a single operating system; it seeks to minimize total costs associated with the acquisition and handling of materials from the inception of materials requirements to the final delivery of finished products to their users.

In most (especially industrial) firms, there exists a need for coordination and perhaps integration of logistics activities. During the past 10 years many firms have made considerable progress toward the accomplishment of this objective, but much work still remains to be done. The concept of LM is primarily a materials organizational tool which has been used in the past and will be used increasingly in the future to

achieve closer coordination and control of a firm's various logistics activities.

The application of the integrated approach to the administration of functionally related areas goes beyond the logistics function. It demonstrates the possibilities of breaking down, with rational, reasonable control, departmental boundaries and "parishes" which had long existed in the company. The growth of logistics management as a development of the systems approach to company control, runs parallel with the increase in computer-oriented thinking in a large part of the industry. As long as the control of logistics begins with the requisitioning of purchases and finishes with the delivery to a customer, the systems approach which is most suitable and logical will be LM.

LM is especially applicable when:

* logistics costs make up a large part of the total costs
* the company has complex and diversified product lines
* the company has a decentralized structure

Among the benefits of applying LM are:

* improved distribution control
* improved inventory management
* decreased purchasing costs
* more effective communication paths
* better supplier/customer cooperation
* provision for the use of "least total cost."

II. DESIGN OF LOGISTICS MANAGEMENT SYSTEM

A. INTRODUCTION

Logistics management (LM) puts the total logistics system at the center and aims at setting "under one hat" as much as possible, of the authority for decision along this flow. At present time, the review of materials flow is most frequently spread among many different hands within the company, with all the risks of suboptimalization and unnecessary costs which this brings.

The design of logistics systems is influenced by various characteristics of suppliers and customers, by the composition of ingoing and outgoing materials and by whether the emphasis is on ingoing or outgoing materials and products.

The focus of this chapter is specifically on the design of the LM system where we look into various ways of organizing the logistics activities in a firm.

The matrix design is suggested for the operation of the LM concept, even though there is no ideal organization which fits all types of firms. Such a merging will help business meet the challenges of a dynamic environment, which is forcing change on organizational forms.

B. LOGISTICS IN BUSINESS PRACTICE

Currently, logistics is most often defined as another function in the firm, such as marketing or finance. In the market oriented firm, the term is often artificially reduced

to include only the physical distribution activities that affect the customer. This view advocates combining functions, such as order entry, warehousing, finished goods inventory control, and shipping, under one man called the distribution manager. The company that is highly dependent on raw materials supply to reduce cost may see logistics as the materials function, which coordinates plant production schedules and raw materials supply.

In either approach, the view is not on the entire materials flow process and may therefore be taking less than full advantage of the import of the concept of LM. Perhaps brief descriptions of case situations will better illustrate this misconception. (Both the names and industries of the companies have been disguised.)

These cases are written by Daniel W. DeHayes, Jr. and Robert L. Taylor at Indiana University [2;38-39].

The United Fixture Company

United Fixtures manufactures plumbing hardware and fixtures; its sales are in the $80 million range. This firm recently created a distribution department to solve logistics problems. The new manager reported to the vice-president of sales and marketing. The department was given the objective of defining customer service standards, then coordinating those standards with delivery schedules and production plans.

Sales had previously been rerouting production orders from the plant to please large customers, and production control personnel could not keep up. The new department was quickly

able to identify the bottlenecks and to institute a system that better coordinated order entry, production schedules, field warehousing, and transportation to meet customer demands.

At the same time, however, sales people devised new methods of circumventing the schedules, once again accommodating favored customers. Purchasing personnel further confounded the situation by complaining at length about the wildly different materials requirements due to the new production schedules.

Despite the favorable impact on transport costs and better on-time delivery, a number of problems remained. Most functions in the firm that interfaced or participated in the materials movement system perceived that the distribution department was interested only in bettering the system that helped finished goods distribution. Furthermore, the distribution manager was upset because he had not been able to gain control over the inventory of finished goods. The vice-president of manufacturing was "responsible for stock control for the company" and was not about to release control over finished goods.

Keystone Parts, Inc.

Keystone Parts took a different approach to meet a logistics problem. A $25 million manufacturer of metal parts for automobiles and trucks, Keystone was experiencing great difficulty ensuring that sufficient raw materials were on hand for

maintaining steady production. A rash of strikes and tighter control over air pollution had caused considerable uncertainty over the supply of critical materials.

Management decided to combine the corporate traffic and purchasing departments and change the name to materials. They selected the former purchasing manager to be in charge of the new department that reported to the manufacturing vice-president. As a result of the change, materials needs were managed better, and substantial transportation cost savings were made. Much better communication was established between all those responsible for inbound materials movement.

Unfortunately, friction soon developed with the marketing and sales service departments. Although routine orders were being handled reasonably well, many shipments posed problems. The materials department refused to air freight heavy parts unless the customer paid the extra cost. Moreover, slow, inexpensive transport modes were being used for international shipments, making order cycle times for foreign customers often as long as four to six months. Marketing personnel were convinced that overall customer service was deteriorating, and that the overly thrifty materials department was to blame.

In both cases, a business logistics application was developed to meet an immediate materials flow need. The form of the operation differed in each case, but the short-run problem of each company was reduced. However, similar and related problems developed elsewhere in the firm, indicating that the original problems were merely symptomatic of much more serious

concerns. In fact, digging revealed that the whole structure of the organization needed to be examined. Both companies had created logistics operations and used them medicinally, hoping to cure the underlying disorder.

What kind of solution should be suggested to these companies? Some may say that the firms should learn from one another—create a materials department for the United Fixtures Company and a distribution department for Keystone Parts. This move might give each company one of each kind of department, but it is not likely. Such a suggestion would merely attack another symptom instead of the basic disorder. In either situation, the over-all coordination of the materials function throughout the firm is still missing.

Others may suggest that if over-all coordination is the key, then why not create a functional department responsible for all materials activities? Business experience with such a super-department is very limited. The power that such a department would have if it truly had total responsibility for the materials process would be overwhelming. Consequently, few such organizations are allowed to be created. If they are created, they are usually done so over a period of several years.

But these companies and others like them need an answer that can be implemented rather quickly. A change of perspective is called for to solve the organizational problem.

LM should not necessarily be thought of here as a function in business. Rather, LM is best thought of as a way of

thinking about solving problems. LM involves a systems view of the entire materials flow process in a firm. Such a way of analyzing problems is difficult to achieve when executives are made responsible for only some fragmented part of the process. But if a firm wants to put someone in charge of logistics, what alternative besides a functional department does it have? To answer this question, one needs to look more closely at the logistics systems concept.

C. DESIGN OF LOGISTICS SYSTEM

In designing the LM system we must take account of a number of external and internal restraints. Examples of external restraints are the competitive system, the transport system, laws and regulations. The projected level of service, existing resources and competitive policy are examples of internal factors which must be taken into account when the system is being designed.

The stages in the solution of the problem can be summarized as follows:

* definition of the system
* formulation of objectives
* establishing what restraints exist
* assembly of information and "trade-off qualifications"
* design of the system
* application and follow up.

These stages are not, of course, separate in time but interact strongly and depend on each other.

During the last few years we have acquired a number of aids which make it possible to carry through the reasoning for the LM approach. For example, we are helped by the application of operations research, data processing techniques, and improved accounting systems which can perform their tasks as information carriers for decision makers.

In most companies there are large gains to be achieved simply by an improvement in the control of the internal materials flow. To process and combine raw materials, semifabricated parts, and components into finished products is a complex process with strong interaction between the various activities.

In spite of great importance of horizontal flows, most companies work with some type of division by function, where the vertical boundaries cut across the horizontal flow and what is worse, where the result is judged with reference to the ability of the various departments to reduce cost or increase the revenue from their own activities without regard to what is happening around them.

In the last few years an increasing number of companies have begun to discover the advantages of integrating the various subfunctions directly connected with the materials flow, and subsequently bringing authority and responsibility under "a single head." By applying the LM approach, the aim is therefore to regard the fundamental purchasing, manufacturing and marketing functions as one integrated system which does not, of course, mean that they have to be united in one

department. By selecting and integrating the most effective combinations of subfunctions such as transport, handling, and stores, we attend to produce an efficient organization.

D. MATERIALS—AND INFORMATION FLOW

The activities of a company can in principle be said to embrace the following main tasks:

* supply of production resources (men, materials, machines and capital)
* production of goods and services
* disposal of goods and services.

These functions must be planned, organized, coordinated, controlled and reviewed. Furthermore, the financial result must be assessed and accounted for. The problem for the company is to bring about efficient coupling between itself and/or the surrounding resources and disposal markets as the case may be.

The starting point for this cycle is, as shown by Figure 12, the needs and wishes of customers. These factors influence the development of products and thereby the planning of production and production itself. To be able to achieve the production planned, a suitable combination of production factors must be supplied from the resource markets. The products and services produced are transferred (distributed) thereafter to customers, and the cycle is complete.

From the moment when specifications are drawn up and production plans completed, many decisions must be taken and

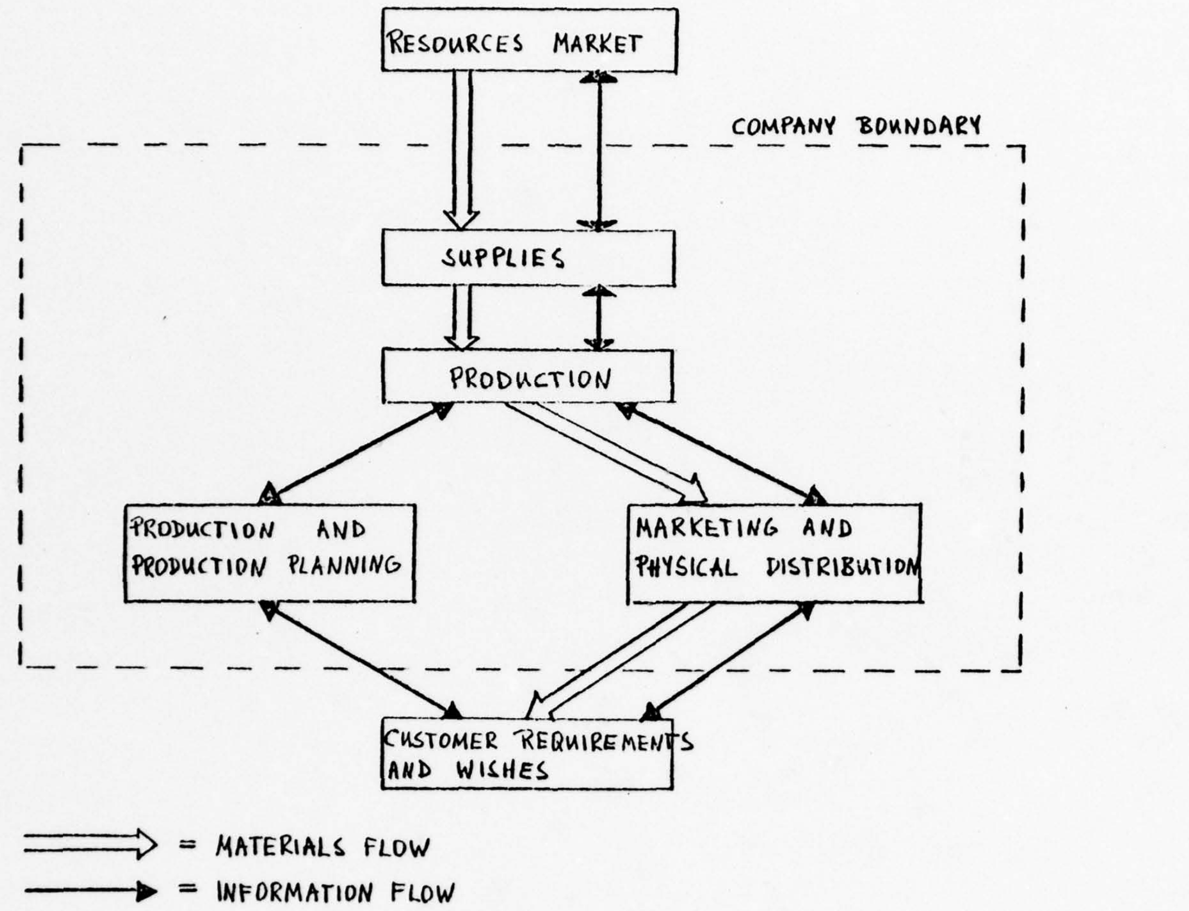

Figure 12. Customer and marketing orientation. The information flows are two-directional and demonstrate the mutual dependency between the components [4;67].

coordinated to control the total materials-information process.

We distinguish between external and internal material flows because differences exist in the opportunities which company management has to control in the various systems. In the same way, we distinguish the external and internal information flows.

Parts of the total system are continuously being analyzed by various manufacturers, wholesalers and retailers. But these analyses are not complete. For example, physical distribution, the control of stocks and the purchasing activities are often studied separately. Frequently, little or no thought is given to the effect of one set of measures on other subsystems, and this can lead to suboptimization even within one's own company.

The total materials-and-information flow from the supplier of the raw materials to the final user is, of course, even more difficult to grasp, and is therefore seldom exposed to any attempt at optimization. Even were manufacturers, wholesalers and retailers to have the same objective, for example increased profits through increased sales, it is not certain that their understanding of suitable methods would be identical. To achieve the greatest possible efficiency, all members of the distribution channel must be conscious of their mutual interdependence.

The total system is complex, however, and in most cases involves many different components with differing conditions of ownership.

This means that no employee has the complete picture and the decision authority for the whole flow, so we have to rely on negotiations and co-planning. Nevertheless, the approach has practical meaning, since it becomes easier to fit together the separate pieces of the system if we perceive that they form integrating parts of a whole. Increased co-operation and co-planning between suppliers and customers are important steps towards increased total efficiency. We must, however, always take into account the influence which co-planning can have on the competitive system.

The total cost concept has somewhat accelerated the movement towards a more flow-oriented look at company activities. We have, for example, to a greater extent come to see the material flow as a total process instead of a number of functions independent of each other; a total cost approach can, for instance, show that an increase in transport costs gives diminished total costs through a reduction in stockholding.

For the logistics system to function efficiently, we must build an information and decision system which has the right control impulses. A control system may be said to consist of an information system with subsystems for the collection of data and for the refinement of data into information, and a decision system with subsystems for the conversion of information to control impulses and for the transmission of control impulses to the object to be controlled.

Each control system must be designed for the needs of the individual company. There are, however, some common factors

which to a greater or lesser extent influence the design of the system. Among these factors are:

* the compatibility of the system with and its balancing against other external and internal systems
* the complexity of the system
* the separation of the physical flow from the information flow
* the external versus the internal flow.

To make one's own total logistics system compatible with the suppliers' and the customers' systems, it is necessary to:

* collaborate with customers and suppliers by the matching of
  - purchasing habits and order procedures
  - materials handling and transport systems
  - ordering times and ordering quantities
* assemble relevant external data for conversion to control impulses.

The complexity of the system depends on the number of components in the system. If a manufacturer communicates with one supplier and one customer, the system is relatively simple, but complexities grow rapidly with each new component which comes in.

If the system comprises several different products, several groups of customers and several suppliers, the communications problem becomes difficult. A further complication arises in that the control of the components in the distribution channel

is divided between several independent companies. It is, of course, considerably simpler to design information and decision systems if a company owns or controls all the elements in the channel than if the control is divided. In the latter case, the task is to make the members of the channel perceive the value to each other of an efficient flow of information.

A third factor is that the way the goods travel (the physical distribution channel) is usually not the same as the way in which the transfer of ownership rights, customer development and the assembly of information take place.

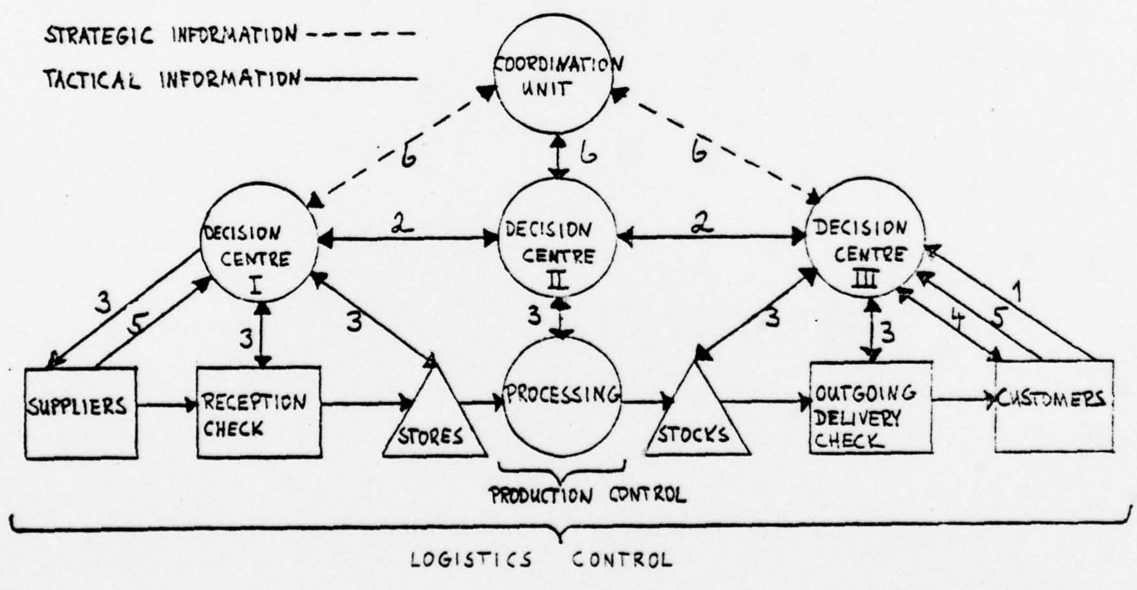

Figure 13. The logistics system with its strategic and tactical information flows [4;87].

Our discussion about the external and internal materials- and information flows can be illustrated/summarized in connection with Figure 13.

The materials goes, as the figure indicates, from the supplier via reception control, and possibly stores, to processing. After processing the products go via the outgoing delivery control, and possibly finished stock in various places, to the customer.

The control system which deals with the flow of materials may be divided into various parts or phases as the diagram shows.

1. The inflow of orders.
2. The coordination and transmission of the information required to other affected decisions centers in the company.
3. Ordering: that is, the transmission of the impulses necessary for the order to be completed.
4. The follow-up of possible adjustments.
5. The continuous contact with the external environment, which the purchasing and selling departments must normally have, to follow up progress and to initiate adjustments.
6. The coordination of the various decision centers for longer-term control.

We distinguish in this way between information flows on various levels, whether the information is strategic or tactical.

We shall now summarize a useful method for the practical application of the approach set out above for the design of a logistics system. How far the limits of the control system will extend, depends on how far the limits of the controlling and reviewing opportunities of decision makers extend.

The strongly interdependent and interactive stages in the design of a logistics system may be represented in the following way:

* The assembly of existing notions about objectives with reference to total objectives and subobjectives (goals).
* Analysis of objectives with a breakdown into operational goals concerned with
  - market share and "reputation" on the market
  - supplier policy
  - productivity and profitability
  - development of human and material resources.
* Objectives and goals for different decision points.
* Definition of decision points and the combination of these into well-defined subsystems (decision centers) which can be assigned to "larger" objectives.
* Outlines of the necessary information and decision systems.
* An outline of the necessary "support" systems (calculation on pay, accounting and so on).
* Design of system projects starting from aspects of integration.

* Cost/revenue analysis and the time schedules of the various systems projects.
* Setting of priorities for the projects.
* Design of systems.
* Application and follow-up.

E. ORGANIZING FOR LOGISTICS

Problems connected with the design of information and decision systems for logistics control are closely associated with the organizational design of the company. The purpose of logistics management is to give a systematic, integrating concept for the control of raw materials, components, half-fabricated and finished goods to, through and from the company. The materials flow cuts across the traditional function boundaries and integrated control of the flow comes into conflict with some "accepted" management principles.

Integrated control of this kind, however, also cuts down costs and reduces lead times. The company management which wishes to exploit to the fullest the inherent profit potential in this concept must be willing to install the materials flow at the center, and this can involve a relatively forceful restructuring of the division of responsibilities in the company.

The problem here is to take care that there is no confusion between LM as a concept—a philosophy—and the adjustment of the organizational structure which the application of the method can initiate. It is therefore not enough to set up a new department called the materials or logistics department,

or something similar, if the heads of departments concerned and other employees do not accept the approach of integrated control of the materials flow.

The goals of the logistics department are, to some extent, in conflict with those of other departments. Subsystems must therefore be balanced against each other, using clearly formulated total objectives. It is evident that a company has several objectives—an objectives structure—which must be achieved.

A primary aim for a manufacturing organization is to convert materials and products to the form which customers wish to have, and thereby employ the production factors, that is people, materials, machines, capital, in an efficient way. This striving for efficiency has the result that when the organization grows, the many functions which must be carried out are divided between different departments, sections and so on by reason of increased specialization.

The specialists attempt to carry out their roles in an efficient way. This frequently means that they concentrate on their own functions without taking notice of the environment. The larger and more specialized a company becomes, the greater are the risks that attention is diverted from the company's total objectives and is concentrated instead on goals which are not always consistent with the total objective.

It has often been the case that supply and distribution activities have to be scattered throughout the organizational structure of many companies and in general are given little

collective attention by management. For example, Figure 14 shows a typical organizational design for a manufacturing firm. Logistics activities such as the selection of distribution channels, the setting of customer service levels, and control of field inventories are commonly a responsibility of marketing. Communications and inventory levels may be a responsibility of the financial arm of the firm. Finally, manufacturing may have the responsibility for warehousing, transportation, and raw-materials supply. Individual logistics activities often show conflicting cost patterns such that a typically organized firm will also have conflicting objectives regarding logistics activities, as also illustrated in Figure 14. It is clear that separate management of each

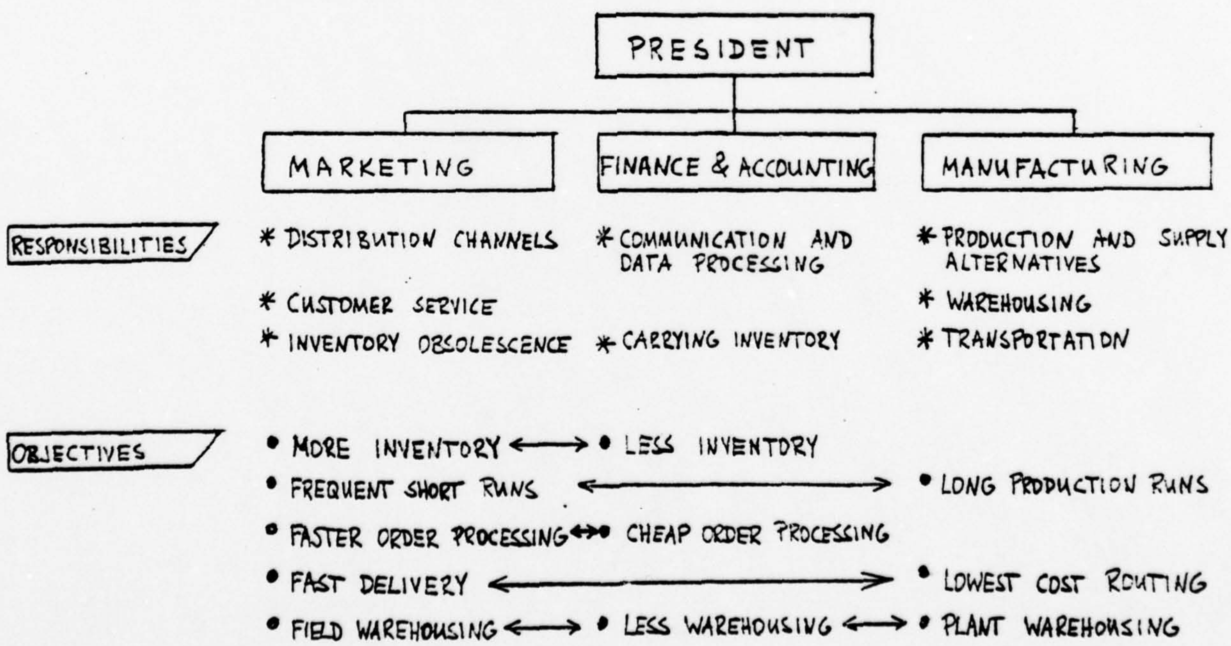

Figure 14. Organization of a typical manufacturing firm with reference to logistics activities [7;426].

of these activities can lead to suboptimum performance of the logistics function as a whole. Recent recognition of these cost conflicts has led management to consider organizational structures and informal arrangements that encourage the collective management of logistics activities to exploit the inherent economic tradeoffs.

Any particular organizational structure by which a firm chooses to manage its logistics activities should be designed to help achieve a number of objectives. Chief among these are (1) activity and function coordination, (2) system planning and design, and (3) system administration.

Activity and Function Coordination

All of the activities of a business firm lie on a continuum, and when these activities are divided into the various functional areas of the firm (for example, marketing, logistics, and manufacturing), there will remain some activities that are not logically the sole responsibility of a single area. Such activities are customer service that "overlaps" between logistics and marketing, and production scheduling that "overlaps" between logistics and manufacturing. If logistics is established as a single, integrated function, such interface activities require coordination between the functional areas. The organization of the firm should be designed to handle the interface activity problem.

The second type of coordination concerns the activities within the logistics function. Logistics activities commonly include (but are not limited to) transportation, inventory

management, customer service, order processing and information flows, warehousing, materials handling, protective packaging, product scheduling, and facility location. Since inventories can be traded against customer service, transportation traded against inventories, order processing costs traded against customer service, coordination is necessary to achieve the best economic tradeoff among the various activities.

Setting up logistics as an organized functional area separate from marketing and manufacturing usually achieves the second type of coordination, since a single manager has the responsibility for the logistics activities. Coordination between the functions is usually not achieved with such a realignment of the firm's organization chart. Instead, it is important to build communication "bridges" between the functional areas and possibly to develop innovative ways of measuring the performance of each area that would encourage coordination and cooperation.

System Planning and Design

The second objective for organizational structure is to make provision for the planning function. The logistics system will be constantly influenced by the changes taking place in the external and internal environment. Planning and replanning for system design and operation should also be a continuing activity. In addition to the planning the line managers perform, planning assistance is provided by a staff

planning group or by technical and managerial assistance purchased by the organization in the form of outside consulting services.

System Administration

The final objective is that the organizational structure should facilitate the implementation and control of plans and policies. In most companies, logistics activities are too broad and complex for one individual to handle entirely on his own. Logistics activities should be divided among different people having special expertise, and different levels of responsibility and authority should be established for implementing various phases of logistical plans. The authority should be commensurate with the responsibility. How much responsibility and authority can be delegated down the organizational hierarchy depends on the capacity of the individuals in the organization to accept it and to deal with it effectively.

The organizational structure should be skillfully designed so that its size is neither overly large in light of the importance of logistics in the firm so that excessive overhead costs are incurred, nor unreasonably small so that the savings in overhead costs are a poor tradeoff against administrative performance. The best size of organization depends on the span of control (that is, the number of individuals that can effectively be supervised by a manager) that is reasonable for the firm. When the activities are involved and vary greatly,

each manager can handle only a few subordinates, and large organizations result.

F. ORGANIZATIONAL FORMS

Traditionally, organizations have been designed vertically, in hierarchies with clear areas of responsibilities and authority. The division can be made from different starting points, for example organization by function, by product, by area and by sequence.

This division of the company, however, can have considerable disadvantages relative to the total efficiency of the company. In this way, for example, the flow of materials and information goes horizontally through the company and cuts across many departmental boundaries.

Other flows of resources too, for example, personnel and capital, are horizontal, but the problem here is perhaps somewhat less insofar as it is not concerned with continuous flows.

Independently of the formal organization structure, a company has inherent strengths which influence its performance. Certain functions are more accepted than others, depending in part on the importance of the function to the company.

Companies which have large and intensive distribution put great weight on this, whereas companies which sell in a more limited market, for example aircraft manufacturers, place the product and product development at center.

There are many alternatives available to top management when considering how to organize for logistics management. These range from doing nothing in a formal way to altering the

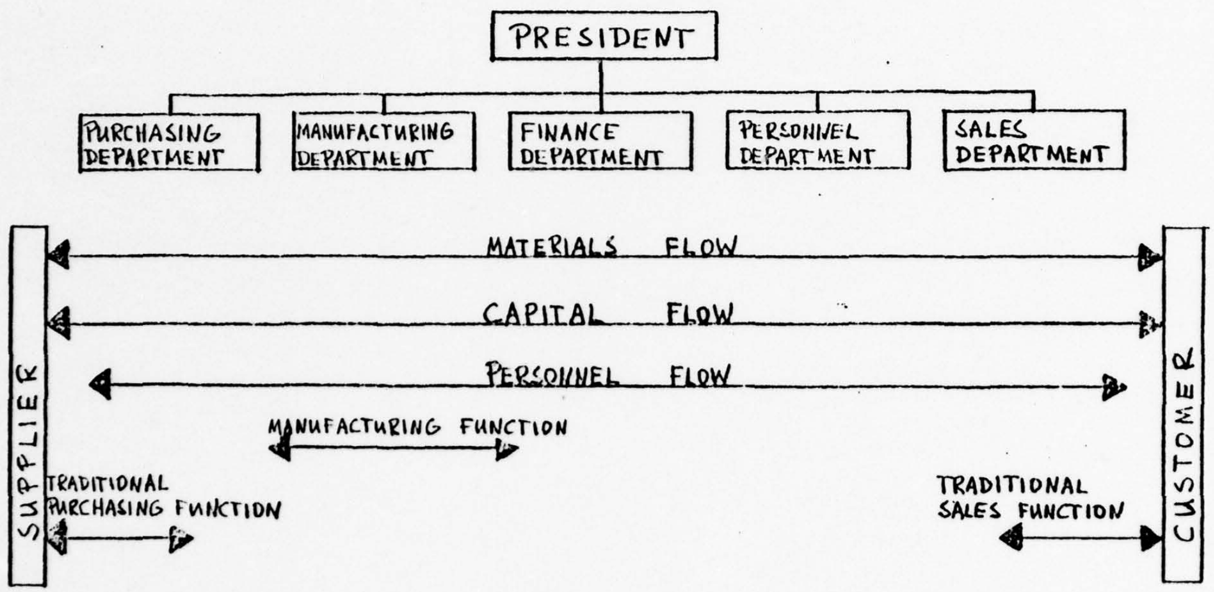

Figure 15. Traditional division in company functions related to the flow of resources [4;43].

existing organization to a highly formalized and integrated organization for logistics.

The Informal Organization

There are many companies that do a first-rate job of managing logistics activities, yet a separate logistics organization has not been established. Formal organizational structures are not mandatory for good management. What is important is that coordination be achieved. Coordination without a formal structure is encouraged in at least two ways. First, if top management believes in the principles of logistics management, coordination will be encouraged through persuasion of subordinates in the direction of top management's own thinking, and suggestions are likely to be made toward developing lines of communication that facilitate coordination. Second, interfunctional and interactivity committees are also facilitating. Even when logistics activities are fragmented among a number of functional areas (recall Figure 14), committees can be used to effect communication between the logistics activities, and coordinated decisions are likely to emerge. If coordination can be achieved through informal organizational procedures, there is the obvious advantage that administrative overhead will not be increased.

Line-Staff Structure

When the decision has been made to formalize the organizational structure, the resulting organization will usually have varying degrees of line and staff responsibilities. The line organization usually deals with daily operational and

administrative matters that are directly associated with the producing, distributing, and selling of products. The staff organization primarily engages in analysis and advisory activities to assist the line organization. Different relative proportions of line and staff create alternative organizational designs. Consider the specific activities of line and staff.

LINE. The manufacturing and marketing functions have long been recognized to contain line activities. In manufacturing, the line activities center around producing goods. In marketing, line activities center around product promotion. Certain logistics activities are also vital to satisfying customer desires in the short term and can be considered line activities.

Which are the logistics line activities? They can be easily identified by simply tracing an order through the distribution system. When a sale is made, the order is transmitted to a point in the distribution system where availability of the product in stock can be determined, a freight delivery ticket can be prepared, and inventories can be updated. This is the order-processing activity. Next, the goods are obtained from the warehouse and readied for shipment. This involves warehousing, materials handling, and possibly some packaging. Finally, the order is shipped to the customer, which involves the transportation activity. As stocks are depleted, forecasts are made of future sales, and orders are placed for restocking. Inventory management comes into play.

Thus order processing, warehousing and materials handling, inventory management, and transportation would be primary line activities. It is hard to see how distribution can exist without them. Packaging and production scheduling might also be included. This activity identification might lead to the line organization shown in Figure 16. A separate manager is established for each activity that is distinctly different in its demands on management.

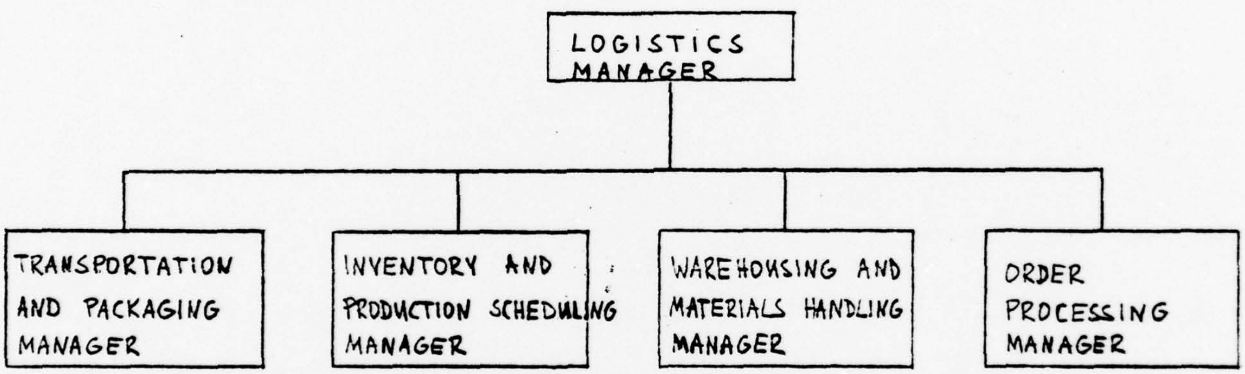

Figure 16. Example of line organization for logistics management [7;429].

STAFF. Line personnel often become so involved in day-to-day operations that little time remains for undertaking major analyses to improve logistics performance. Such assistance is economically provided by a staff group when there is a substantial and constant need for the group's services. Otherwise, assistance may more economically be provided by outside consultants on an as-needed basis. The staff group aids in

analyzing and planning such activities as warehouse layout, warehouse location, materials-handling, system design, and inventory control.

Staff groups occur in organizational structures in two ways. They may be the dominant coordinating force, or they simply may be appended directly or indirectly to the line organization.

A physical distribution organization, for example, may be staff only without a line organization. The staff group in this case provides a coordinative effort in addition to planning, analyzing, and advising. An attempt is made to coordinate the various logistics line activities as they appear in marketing, finance and manufacturing, that is, scattered throughout the organization of the company. One way of organizing logistics around staff activities only is shown in Figure 17.

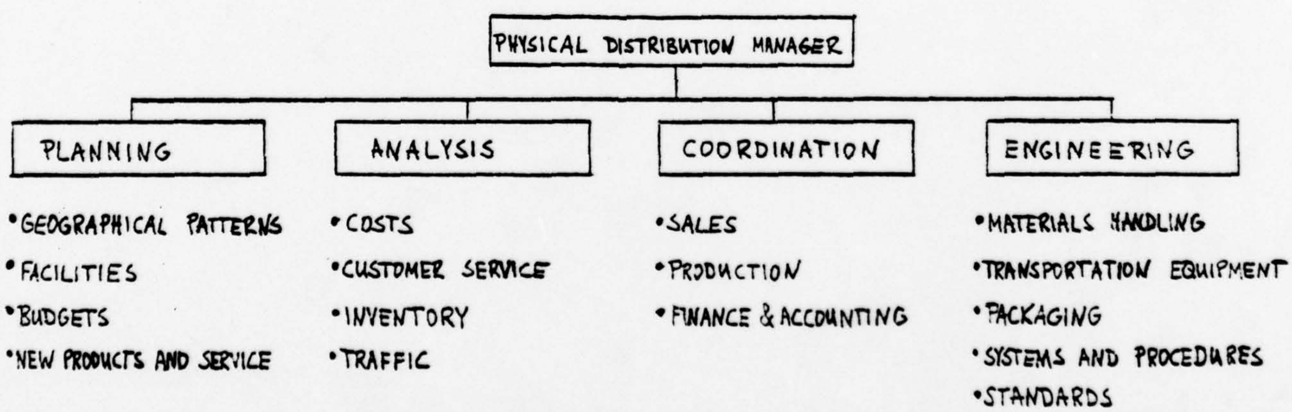

Figure 17. Example of logistics organization around staff activities only [5;97].

Staff activities may also be integrated with the line organization. The logistics line organization may have appended to it a planning group. The group is under the direction of the logistics manager and deals primarily with logistics problems. Alternatively, the staff activities might be handled by a staff group having broad responsibilities for providing analysis, advice, and planning services to all functions of the business. The group would be located high in the organizational hierarchy and at central headquarters for the multidivisional firm.

Line vs. Staff

The relative importance of line and staff can be debated when one is establishing a separate logistics function. However, the order in which they are developed is important. As a general guideline in establishing a physical distribution department, the line function should not be created unless supported by a competent staff function. The line organization development should lag staff organization, but the line organization will grow in importance to equal or surpass that of the staff organization.

Placement of the line organization in the organizational hierarchy is perhaps more critical than for staff. In order to achieve effective coordination with marketing, manufacturing, and accounting, the logistics manager should be on an equal level with the managers of these functional areas. Since the functional areas of the firm are somewhat autonomous units, the ability to be persuasive in realizing functional goals and

receive a fair proportion of the company's resources, depends in part on the responsibility and authority delegated to the logistics manager relative to that of the other functional managers. In contrast, staff can be effective in its consulting role from most any level in the organization, though a high organizational level seems to be favored among firms.

Basically, there are three ways to organize logistics activities, namely; grouping line activities only, grouping

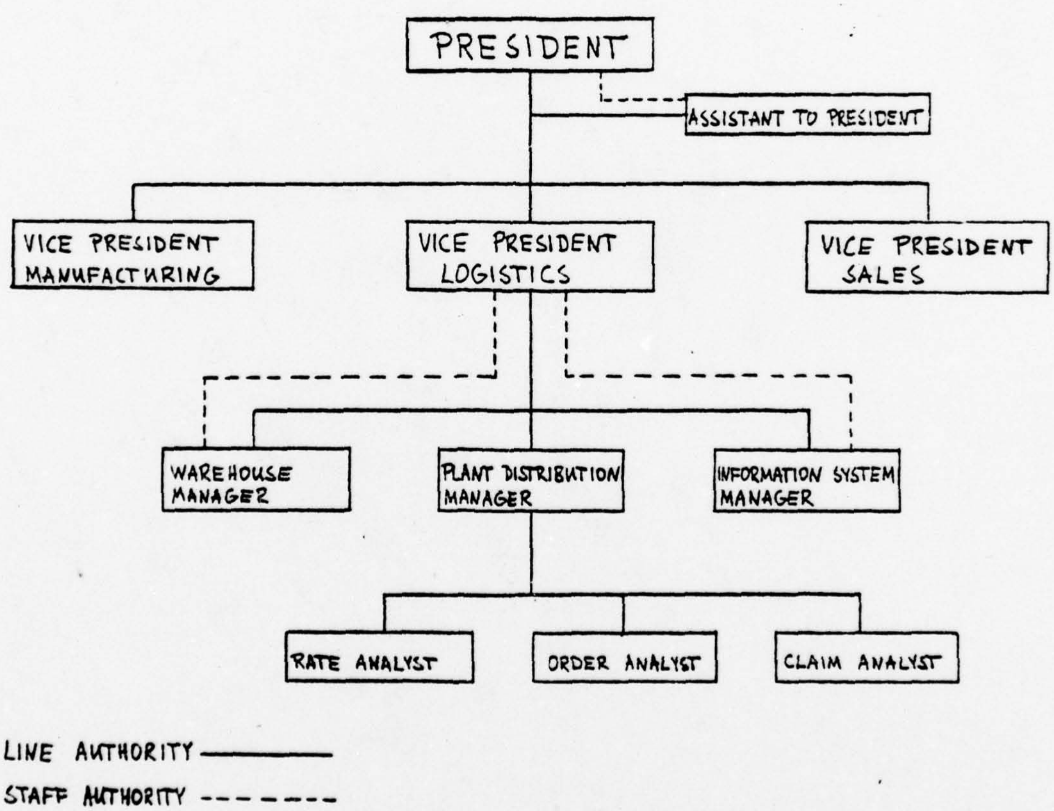

Figure 18. Line and staff relationship in a logistics system [1;35].

staff activities only, and combining line and staff activities. Regarding these three divisions, Figure 18 depicts an organizational structure where both line and staff relationships are formerly established. As illustrated, the vice president for logistics reports directly to the president. Also, he enjoys line authority to the warehouse manager, plant distribution manager, and the information system manager. Staff authority, moreover, extends to the warehouse manager, and information system manager. In this situation, the executive's jurisdictional purview encompasses the total flow of product and materials.

Centralization vs. Decentralization

Placement of line and staff clearly comes to issue when the centralized and decentralized organizational structures are considered. There are many examples in which companies have created autonomous organizational units around their various product groupings. Decentralizing the organization of the company in this way makes sense when the products are distinctly different in their marketing and manufacturing characteristics. It does not necessarily follow that the logistics organization should also be decentralized. It is possible that the products of several divisions may be enough the same in terms of either their distribution or supply characteristics that a common logistics system may be used. That is, combined use of warehouses, transportation, and order-processing linkages can yield some economies of scale that would not likely be encouraged if logistics activities were controlled decentrally.

Thus, even within multidivisional companies where marketing, manufacturing, and accounting have been decentralized, logistics activities may continue to be centralized.

Establishing a separate organizational unit for logistics in each division or product group of a company is reasonable when the administrative advantages of decentralizing outweigh the economies that might be gained through centralized administration. However, the line organization may be decentralized while the staff activities remain centralized. The performance of staff is not affected by the volume of product flow in each division, but it is affected somewhat by the vantage point from which it must operate in the organization. In the decentralized firm, staff seems to thrive better and be less costly if it is centralized.

The issue of whether logistics activities should be centrally or decentrally organized is mainly of concern to the large, multidivisional company. Small companies naturally have a centralized logistics organizational structure. The reason for this is that there generally is too little product flow volume to support more than one logistics system.

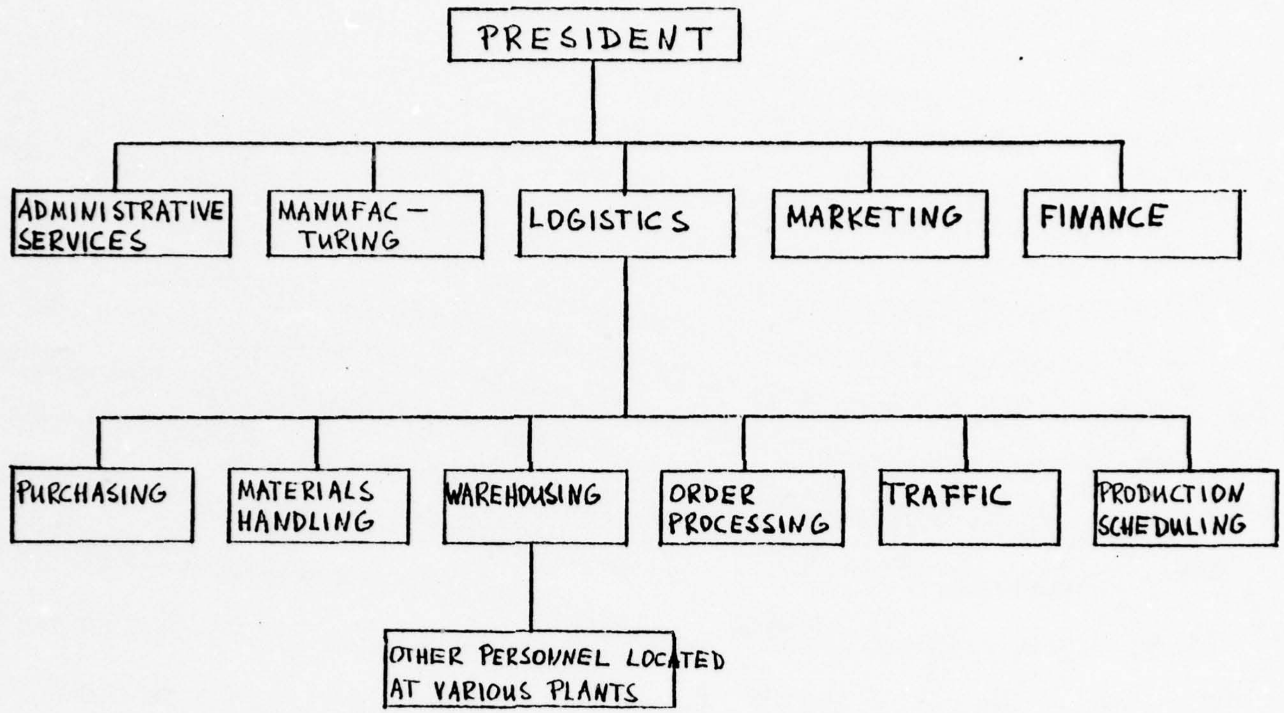

Figure 19. Centralized organization structure for logistics [1;38].

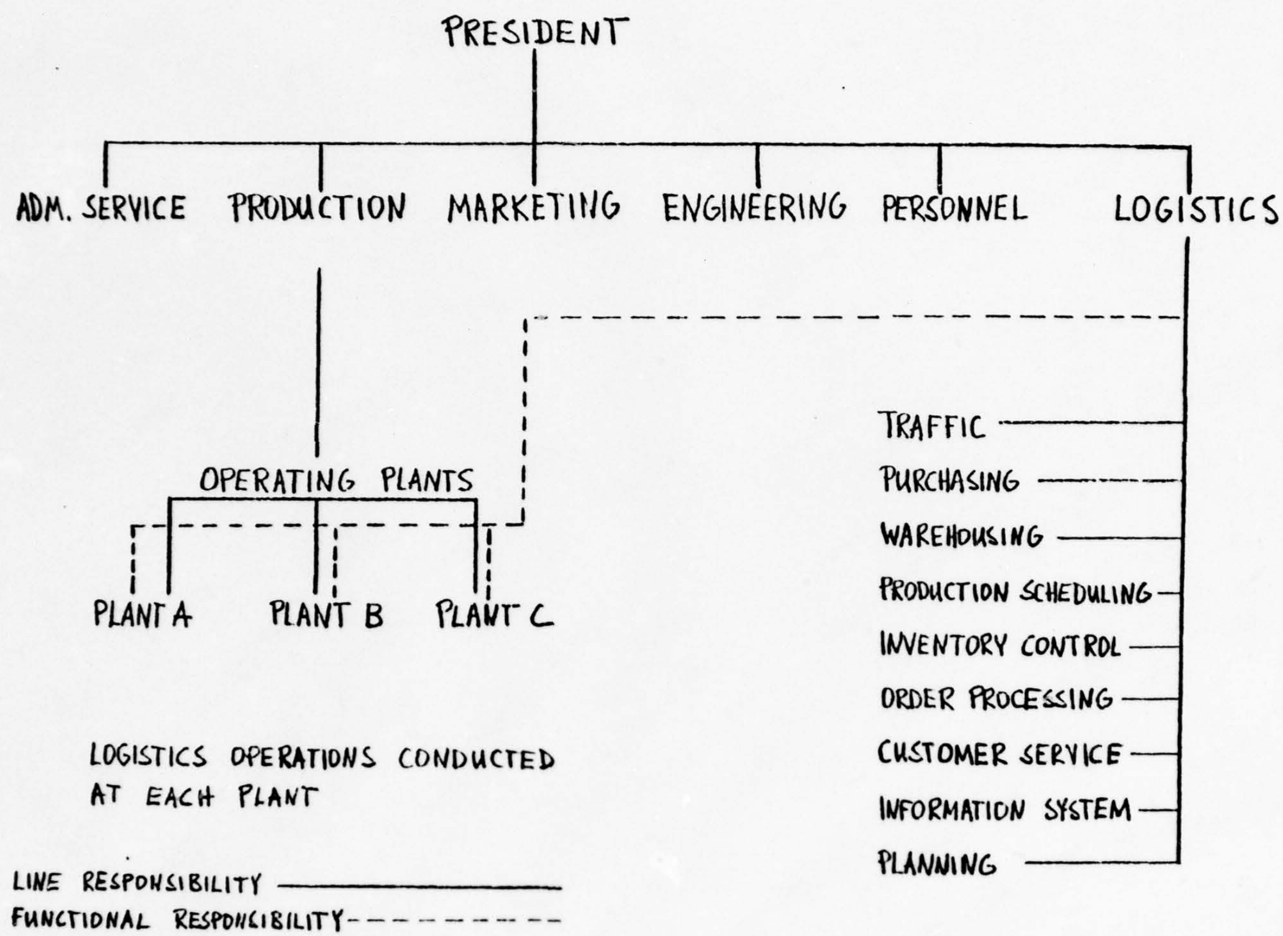

Figure 20. Decentralized organizational structure for logistics [1;42].

G. MATRIX DESIGN

Logistics management as it has been developed here, should not necessarily be molded into traditional organizational structures. Such action could underutilize the power of the LM concept. However, current advances in management theory offer more feasible approaches to the problem.

J. R. Galbraith has formulated a number of alternatives for organization designs, ranging from simple rules and performance programs through complex integrating mechanisms. We shall use a condensed version of this structure (see Figure 21) to select the nature of a feasible implementation method for the LM concept within an organization.

The choice of one of three organization structures should be made for logistics. A complete functional orientation should be discounted here because LM is an integrative concept rather than a technical function. It works best when functional

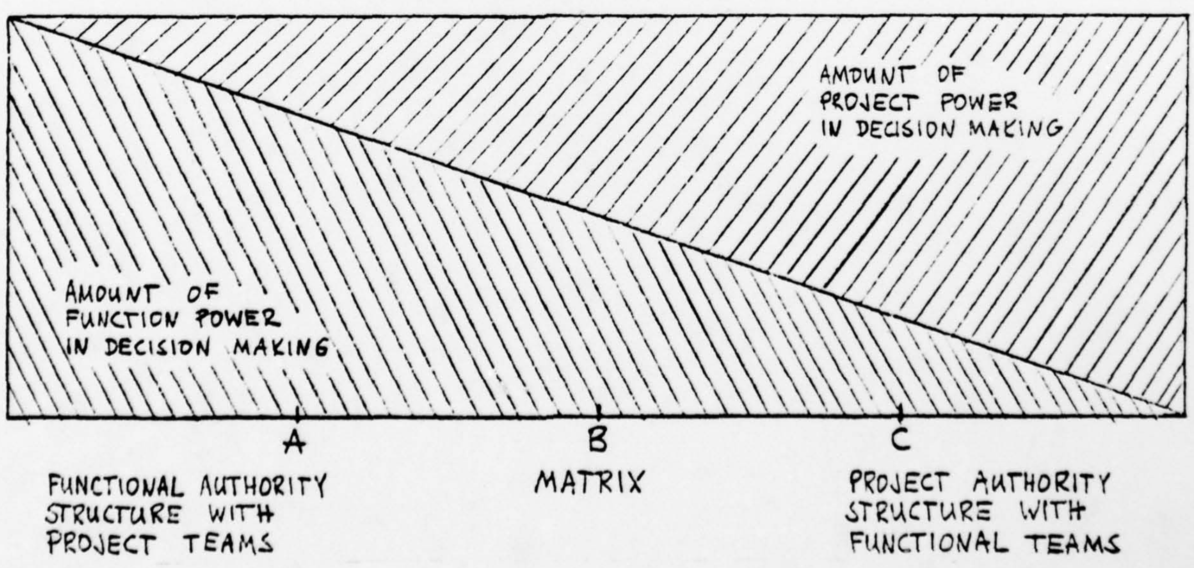

Figure 21. Relative decision power as a function of the authority structure [2;42].

boundaries are cut. Figure 22 exhibits a typical functional design for logistics that will be used in drawing comparisons with later designs. The functional design corresponds to the extreme left point (A) in Figure 21. Note the large amount of decision-making power by functional managers relative to project managers in this case. This situation is the one that allows for the most functional suboptimization; logistics in this case could become another suboptimizer. The cases discussed in the beginning of this chapter show some of the pitfalls in this approach.

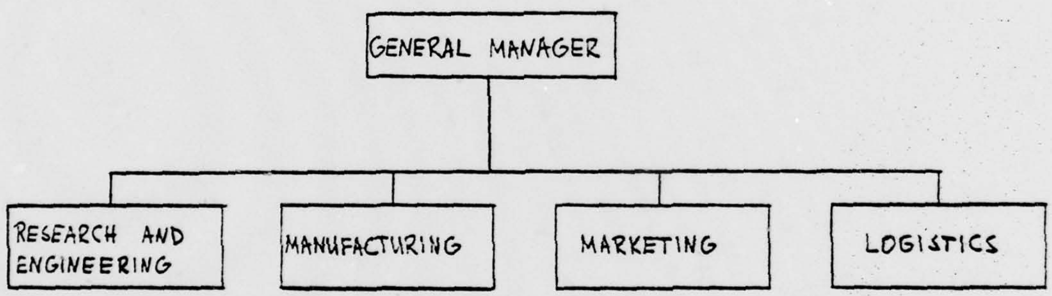

Figure 22. Organization design for logistics as a function.

Total program management is at the other end of the spectrum (point C in Figure 21) and completely subordinates the functional areas to a program. In this case, logistics would assume the role of a program in which the entire company participated. The resulting organization structure is illustrated in Figure 23.

Some serious implications are contained in this design. Logistics considerations are given paramount importance, and systems cost minimization is equated with organization profit maximization. Demand generation and production processes are considered only in respect to how they contribute to the logistics system. A "pure" program approach, in Galbraith's terms, does not, therefore, offer the solution either. The LM system is equated to the whole firm for performance. This concept violates the total systems orientation taken earlier, which identifies logistics as one of several sub-systems. The answer must therefore lie in between.

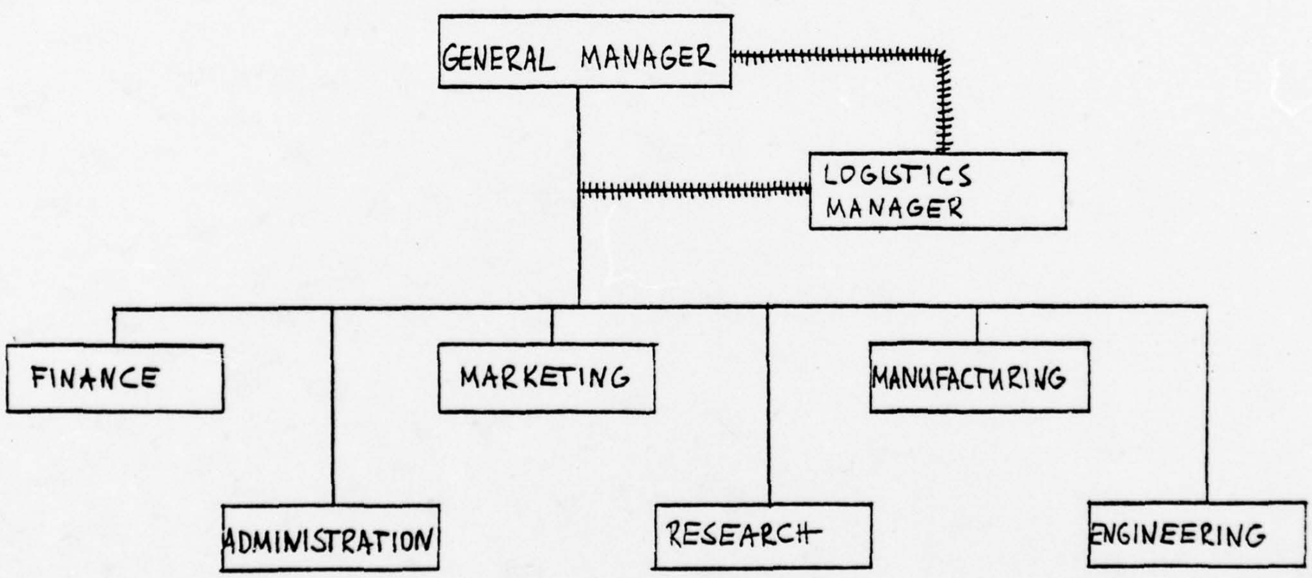

Figure 23. Organization design for logistics as a program [2;43].

The matrix organization (point B in Figure 21) might be the epitome of the joint problem solving and shared authority that is inherent in the logistics systems concept. Such a balanced design ensures that logistics serves the needs of the organization without planned bias. Unfortunately, some managers today view matrix management as a fad, even though the term has been in use for quite some time. (In a sense, the idea can be traced back to Frederick W. Taylor's "functional foremen," where each worker had eight specialized bosses directing him, and each boss was in charge of a specific phase of the work cycle.)

Matrix management is associated most often with the aerospace industry. Just as logistics considerations were adopted from other settings, so can the organizational means for implementing logistics be borrowed as well. It is the logistics systems concept, applied to a variety of organizations, that clearly establishes the practicality of the matrix organization.

The matrix structure is illustrated in Figure 24. This type of structure is built around specific programs represented by the horizontal emphases. Each program manager, such as the logistics program manager, is responsible for his program within established time, cost, quantity, and quality constraints. The line organization (the vertical emphases) develops from the programs but is now a supporting relationship.

Management by program objectives or results is critical to the way of thinking and working in a matrix organization. Instead of a line-and-staff relationship, there is a web of

relationships, all acting and reacting in harmony. The logistics manager can assume his intended role; he becomes the over-all coordinator among a whole series of functions.

The matrix design offers three distinct advantages. First, responsibility centers, such as logistics, can be designed to permit management by objectives. Resource utilization can be measured and accounted for in terms of over-all achievement and contribution to organization goals. Activity centers, such as production or marketing, can then be put into the perspective of supporting these goals through complex interrelationships.

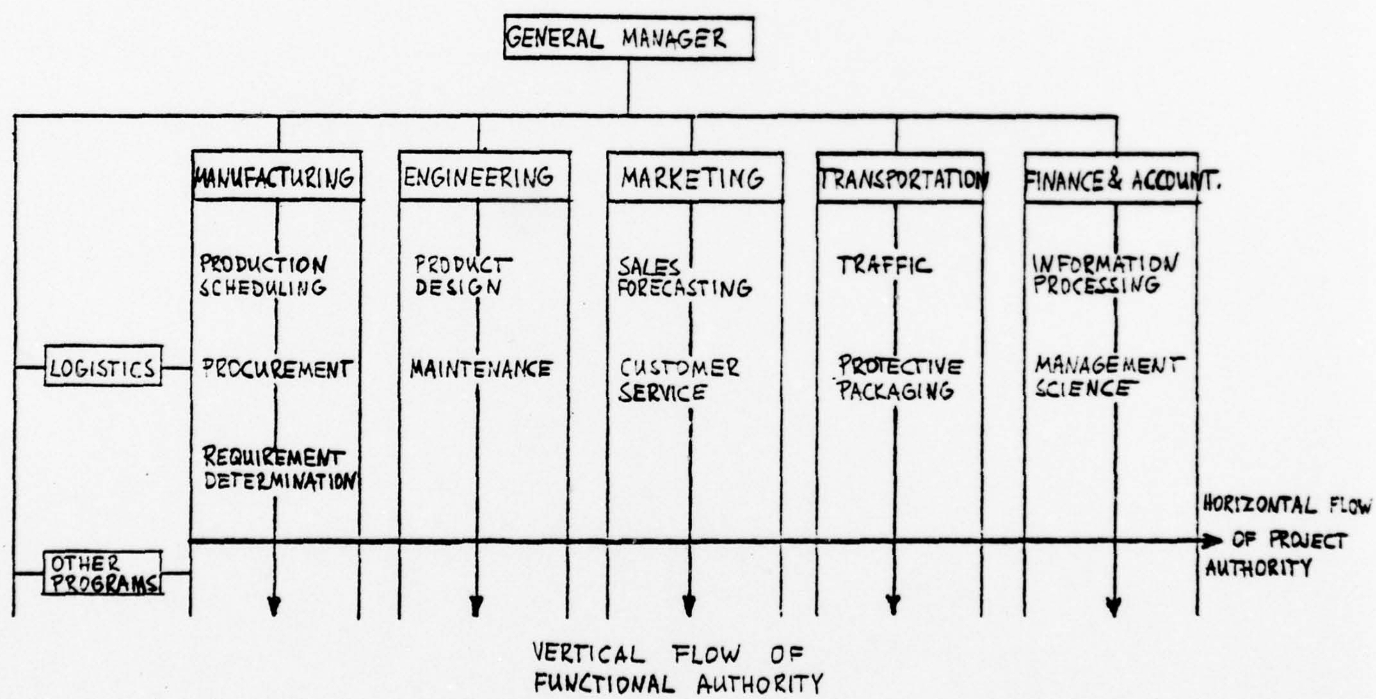

Figure 24. Logistics system management [2;44].

Second, the matrix is flexible. It can be adopted to meet the requirements of specific organizations. Thus, the unique demands imposed by one organization need not be included in another's design, yet both organizations can use the matrix structure.

Third, a matrix is proactive rather than reactive. The management functions of planning, organizing, and controlling are integrated to identify and meet requirements by the program manager rather than being held in reserve until problems arise. The logistics manager is therefore better able to be an integrator and can be rewarded accordingly. Synergistic results meet the needs of today's rapidly expanding economic, technical, and social environments more successfully.

In essence, the logistics manager in the matrix design is part of a shared authority system. He is responsible for the activities outlined for the totality of the system but not each of the traditional areas (for example, traffic, production scheduling, warehousing and inventory control, forecasting, and information processing). There is, therefore, concentration on the system and not only on components. The expenses of these activities are accountable both to the logistics program office and the functional department.

Logistics objectives are set, and the functional managers (such as engineering, production, marketing, and finance) are judged in part on how well they meet the logistics goal as well as their own. Scheduling, coordinating, and directing logistics activities are, therefore, in consonance with the

stated objective. The logistics manager shares decision authority and accountability for the logistics program with the functional managers.

Often, the matrix organization is thought to be a temporary structure, existing only for the life of a particular project. Logistics is not a temporary phenomenon, however, and thus the matrix can be afforded permanence. Designated functional personnel must establish a continuing relationship with the logistics program center. It is this center which formulates and coordinates the boundary relationships (interfaces) between functions. One advantage of this approach over a strict functional orientation is that functional personnel are better able to understand their boundaries under the matrix design. The result in on-going situations is that the matrix approach allows the sharing of responsibility and authority among managers. These advantages do not accrue without conflict, however.

Avots indicates a number of potential causes of conflict in implementing a matrix design. The most important of these is the failure to find properly qualified personnel to handle the cross-functional responsibilities. In this case, we need someone with training and experience in logistics. G. J. Zenz found this difficulty to be perceived as most important in a survey of firms trying to implement the concept. Other critical problems are lack of support from top management, inadequate information flow, and absence of a suitable reward base. To overcome these conflicts, it is necessary to treat change

not as a technical restructuring, but as a realignment of human relationships, which would include such things as values, attitudes, and behavior, and would allow sufficient time for change to occur.

The most obvious problem with the matrix once it is in operation, concerns the question of authority relationships. When a conflict arises between the logistics manager and a functional manager (for example, the manager of manufacturing), there must be a procedure for resolving the conflict. Such a resolution might depend upon relative negotiating power as the authority base. However, a continuing design must allow for a more determinate authority.

H. IMPLICATIONS FOR MANAGEMENT

If we study the organization schemes for various companies, we often find large differences in formal structure, even in companies which manufacture similar products. These differences are greatest on "higher" levels, though we also find some differences within subdepartments and groups. This shows that similar functions are carried out in different ways, which depend partly on staff and economic resources and on location.

Logistics management brings certain organizational problems for functionally organized companies. The materials flow influences every function and the conditions under which they must work individually. Many companies choose to divide the responsibilities for logistics among several departments affected, but this kind of division leads to difficulties, since we cannot then:

* satisfy the necessity for coordinated logistics planning
* specify the requirements for planning and control
* establish measurements of efficiency which are consistent with total efficiency and with allotted areas of responsibility and authority.

It has been a mistake for business organizations to view logistics as separate functional activities. The two companies used as examples in the beginning of this chapter adopted logistics as a corrective tool to solve immediate materials flow problems. The long-run failure of their actions could have been avoided if they had realized that LM is best perceived as cross-functional. In other words, it is a system embracing many different functional activities within the organization.

Both companies were later persuaded to implement a form of a matrix organizational concept as the best way to make LM work in their individual situations. Both have achieved substantial success, but have experienced difficulties with the shared authority obstacle.

United Fixture chose to appoint a man as executive vice-president in charge of logistics. In this job, he had no responsibility for a large staff or several departments reporting to him. Owing in part to his prestigious title and his tactful approach, he and two assistants were nevertheless able to achieve the kind of over-all logistics coordination that had eluded other functional organizations.

Keystone Parts found that one of its operating executives had been performing a sizable part of a matrix organization's functions on an informal basis for several years. Management chose to expand his scope of authority and action. In addition, they gave him the job of managing the new logistics office, which reported directly to the president of the firm. After some initial hesitation in his new office, the executive was able to obtain much better logistics control.

Merging logistics with the matrix design could help organizations to meet the logistical challenges of a dynamic environment. Some years ago, the aerospace industry was characterized by a rapidly expanding technology, perhaps the most dynamic of any industry at the time. Logistics considerations and matrix organization were some of the organization modifications developed to meet these demands. Now, the same technology advance has engulfed the economy in general, and changing value systems are forcing change on organizational forms. Thus, the LM systems concept as a basis for organization design has expanded applications. The logical relationship that developed here has some additional implications for management theorists and practitioners.

I. GUIDELINES FOR SELECTION

The form of the organizational structure that a firm chooses for administering its logistics activities depends on (1) the type of firm that it is, (2) the importance of logistics service, and (3) the enthusiasm of top management for logistics.

Type of Firm

The type of firm and the nature of its activities give an indication of the importance of logistics activities to the firm and how they are likely to be organized. First, the expenditures on logistics activities in relation to sales will indicate whether separate attention can be given to logistics activities relative to the other activities of the firm. A firm in the machinery industry, where logistics costs average 10 percent of sales, is not likely to devote much organizational attention to logistics activities. In contrast, a firm in the food industry, where logistics costs average over 30 percent of sales, has a much greater incentive to establish a separate organizational unit to control the costs and performance of these activities.

Second, the type of firm gives a clue as to how logistics activities will be organized when logistics costs are significant. Four types of firms can be distinguished. First are the extractive and agricultural firms. These firms provide basic raw materials (products of mines, wells, land, etc.) to other industrial firms and the consumer. The major logistics activity is transportation on the distribution side of the firm. The logistics organizational structure of these firms is likely to focus on this primary need. Second are the marketing firms. Examples here are the retail stores, where products are received by the firm in large lots and distributed in small unit quantities. Unless the retail store has a substantial delivery activity, the organizational focus will be

on the supply side of the firm. This usually means that purchasing and inventory control become key activities. If delivery (distribution) is important, as in mail order firms, logistics organizational structure will tend to be balanced between supply and distribution activities. Third are the manufacturing firms. Manufacturing firms typically acquire raw materials or semifinished goods, process them, and distribute them to their customers. Because both supply and distribution activities are important, all typically noted logistics activities are likely to be included in the logistics organizational structure. The structure may be balanced toward supply or distribution, depending on the specific situation of individual firms. Fourth are the service firms. Hospitals are good examples. Such firms typically consume their inventories in producing services. Thus, only supply-side activities are important to the logistician. Organizationally, we would expect to find logistics activities centered on the purchasing function.

Customer Service

The need for distribution service may be a determinant as to whether logistics is separated organizationally from the remaining business functions. Since customer service is a function of a number of variables, including order processing, transportation, and inventory levels that may be scattered among several functions of the firm, collecting these logistics activities under a single organizational unit can lead to a higher level of customer service at lower total cost. If

customers are not too service-sensitive, that is, if price and personal relationships tend to be more important to the customer than quick, reliable processing of his order, there will be no strong incentive to reorganize the firm on the basis of increased revenues that might be gained from improved service. Of course, reorganization may still be argued on the basis of economic efficiencies.

Managerial Enthusiasm

Much has been written about the benefits to be gained from repartitioning a firm to establish a separate logistics function. A great deal of managerial enthusiasm has been generated for such a reorganization. It is clear that there must be managerial enthusiasm and support for logistics reorganization to ensure its effectiveness and continuation. However, depending on the extent of this enthusiasm, the newly formed organization can suffer from too much as well as too little enthusiasm for it. Too much enthusiasm may mean that management is expecting unrealistic performance from the new group, or that the activities and standards for the group may follow the inflated "gee whiz" stories about the potential cost reductions in physical distribution often found in the literature. Failure may come when actual performance does not match the unrealistic and distorted performance expectations of management. Too little enthusiasm may also lead to failure. A weak organization may be created that has neither adequate responsibility nor authority to deal effectively with the logistics problems as they exist in the company. Managerial

enthusiasm does shape the logistics organization and contributes to its ultimate success or failure as a function.

There is no ideal organization which fits all types of company, but the choice of the form of organization for the logistics system is influenced by the problems with which it confronts us, and by the importance of the materials flow relative to other functions in the company.

The result of a reorganization following the logistics management approach will come to depend mainly on the ability and motivation of the personnel, as well as on the organizational structure selected.

The importance of motivating personnel and "selling" them on the approach can scarcely be exaggerated, and this must be taken into account during the planning and introduction phases.

When selecting a form of organization, we should ask ourselves what influence this will have on opportunities for specialization and whether these are sufficient for efficient performance. We should further take into account how a choice of organizational structure influences the possibilities of integration and the opportunities for employees to communicate with each other.

Whatever organizational form we finally select depends on the external environment of the company, markets, technology and so, and on internal conditions such as, for example, objectives and personnel resources.

J. REVIEW

Many of the significant organizational issues that surround the performance of logistics activities have been investigated in this chapter. In most firms, no formal logistics department exists. Nevertheless, the logistics work functions are performed. Although a majority of managements maintain no distinct logistics unit, many firms have recognized the benefits of a separate department to integrate and coordinate logistics activities.

If a separate logistics department is created, management must decide what authority to grant to the unit. Many logistics practitioners contend that the activity will not receive adequate managerial attention unless it occupies a line position. Nevertheless, some logistics functions are fundamentally staff oriented, others are clearly line oriented and some are matrix oriented.

Centralization or decentralization of operations pragmatically depends upon management's delegation philosophy. In many instances, logistics is centralized while in other situations the work functions are aligned by division. Also, under certain circumstances the logistics department is centralized yet exercises functional responsibility over decentralized operations. Summarily, it is sound to conclude that logistics activities should be organized and aligned in such a manner that the firm's goals and objectives are achieved. Indeed, no organizational structure is sacrosanct.

The basic issue in logistics organization is how to achieve coordination or cooperation among activities, functions, and firms so that logistical plans can be implemented effectively. Organization should facilitate optimum logistics performance and is in general guided by the total cost concept. The organization should be considered on three levels. Grouping relevant activities together and managing them collectively as a logistics function has received the greatest attention. In certain cases, the payoffs have been great as a result of this activity realignment. Much less considered have been the problems of interfunctional and inter-organizational cooperation. The potential benefits may far exceed those from direct activity management. However, achieving cooperation among functions within the firm and among firms beyond their legal boundaries, when cooperation is likely to be largely voluntary, is a highly complex organizational problem. Undoubtedly, in the future logistics organizations at all levels will guide on cooperation as the key to organizational effectiveness rather than formalized organizational structures that in the worse cases could create as many coordination problems as they resolve.

III. APPLICATION OF LOGISTICS MANAGEMENT

A. INTRODUCTION

Application of the systems approach to logistics management requires cutting across the traditional lines to group-related logistics activities. At the same time this requires implementation of decisions that may not be in the best interest of a particular department or segment of a department, but are nevertheless desirable for the firm as a whole.

The most complex task facing top management interested in LM is that it must often form a department from already existing people, offices and hardware. It would be much simpler to draw up a plan forming a new department, then hire the necessary people and buy the needed equipment. What makes the implementation task difficult is the fact that the logistics department must collect present activities and personnel that have been operating in traditional departments in various phases of sophistication with entrenched relationships and techniques.

A changeover plan should be developed to include first, the objective to be attained, and second, the techniques of the change itself. Since the phase-in of these many components might require as much as several years, intermediate performance goals should be established within the framework of the overall plan.

We shall now look further into analysis and planning for LM systems, then the development of such a system, and finally

how to measure and control the performance of the logistics activities.

B. ESTABLISHMENT OF THE NEED FOR REORGANIZATION

Organization for logistics management is bound to be difficult to the extent that a company attempts simply to graft such efforts onto its current organization structures and management practice. This is characteristically a problem of implementing systems management generally. Of course, the problem is that the classic marketing-finance-production triad is itself a system of management organization, and to expect it to mesh easily and compatibly with a new and different management approach might be expecting too much. Something has to give.

New titles abound in business: Vice President Data Processing, Vice President Distribution, Vice President Customer Service, Vice President Materials Management, Vice President Information Systems, etc. These are commingled with more traditional titles: Vice Presidents of Production, Finance or Marketing. The result is frequently and naturally an organizational shifting and groaning like the clashing of ice masses in an arctic ice pack.

Of course, the phenomenon of change is not new. An astute observer of his contemporary scene wrote long ago:

> It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage, than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new ones.

Niccolo Machiavelli wrote this in 1513. Machiavelli knew whereof he spoke. Initiators and implementors of logistics system management concepts would do well to heed his words.

How do titles such as Traffic Manager, Purchasing Manager, Production Control Manager, or Warehouse Manager square with the title Logistics Manager? How do you pull together (if you should) a number of functions and activities previously and presently scattered through an organization structure? What do you do with what is left?

One corporate president became entranced with the logistics concept and set out, on paper, to transform his company's organization to accommodate all the wonderful new logistics ideas. He subsequently reported that he had approached this task with great zeal; he switched around a number of management responsibilities, modified various activities, changed many reporting relationships, centralized authority in some places while decentralizing it at other points, and, when he was finished, "I found I had made the entire company into one giant logistics department! Nobody on the chart was making or selling our products!" Somewhat chastened by this experience, he went back to the drawing board with more modest objectives in mind.

The moral of the story is that one should approach the drawing board with care and caution. Certainly one of the first useful steps to take is to define the issue (and its attendant problems) that one faces. What are we dealing with? What are its boundaries and dimensions?

It would not be wise for the management of a firm to ignore completely any activity carried on by the firm. The question here is not whether the activity, in this case logistics, is too small to deserve attention, but rather whether it is of sufficient importance to warrant or require that management recognize and deal with it as a significant function in the firm.

The question immediately arises, how can one assess the importance of the logistics function in a given firm? Further, how can one express it? Can it be stated as some sort of index, or ratio, or in any quantitative manner at all? Or must it be a subjective estimate? If it is a subjective estimate, can it be made sufficiently definite to serve as a useful guide to management in deciding whether to recognize logistics as a function deserving of separate recognition in the organization structure of the firm?

Rarely will the need be as pronounced as that set forth by the President of the Norge Division of the Borg-Warner Corporation, the manufacturer of a line of gas and electrical appliances, several years ago at a time when the Division's logistics activities were organized in the manner shown in Figure 25. In his words:

> In analyzing the problems of Norge (and I think the same problems are common to all appliance companies to some degree, and perhaps to other types of manufacturers as well), certain key facts emerge: ... the price of our products virtually doubled in moving from the end of the production line to the consumer; ... there were at least six departments within our company alone, not to mention others at our distributors and retailers, which contributed to this drastic rise ... but which were not working under a common direction or even a common policy.

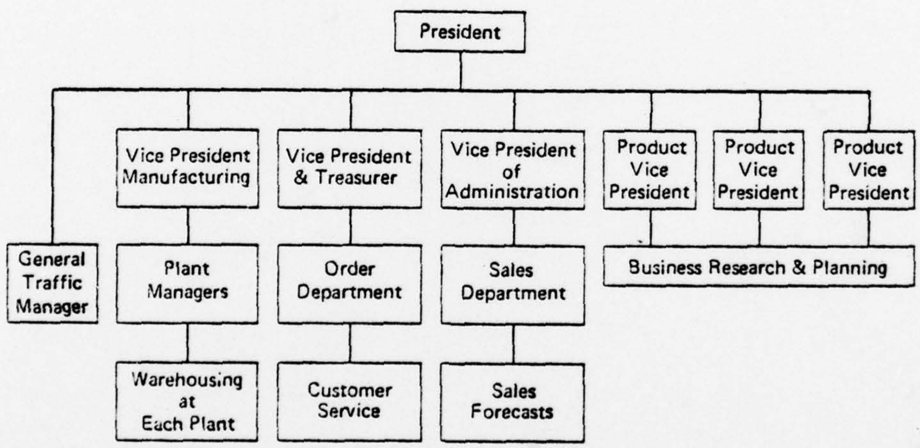

Figure 25. Condensed organization diagram showing the dispersion of physical distribution functions at the Norge Division of the Borg- Warner Corporation prior to 1964 [8;678].

> Each ..... was concerned with the costs which it incurred, but could hardly care less about whether by incurring a higher cost in their particular department they could lower total cost. We had a business forecasting department which forecast overall sales levels. Then, in production meetings, these forecasts were revised by the sales department and turned over to the plant scheduling department which further revised schedules to suit plant convenience. (Plant convenience, you know, means running the same model at a fixed rate forever.) The order department ... was never consulted on scheduling and provided a pretty useless second guess on shipments, since by that time we either had the products or we didn't ... Finally, the traffic department shipped the 'best available way,' which is an optimistic way of saying shipping was purely a matter of the expedience of the moment. Somewhat independently of all this activity, we had a warehousing department at each of the plants which came periodically to our attention as one or the other incurred expense for outside warehousing, but otherwise they were left to their own devices.
>
> When we wound up with too much of any one product, we would develop what is referred to in the industry as a 'loading program.' Which means we tried to push the surplus off on the distributor on the theory that if we loaded him, he would in turn unload onto the dealers. At least one flaw always seemed to be present in this type of program: in order to load the distributors, we had to give special terms, both price and financing, and as a result our accounts receivable relative to sales were formidable indeed, but our gross profit negligible.

A report was prepared which defined the specific deficiencies traceable to the inadequate physical distributing system. These included habitual complaints from the parent company, objecting both to excessive investment in inventory, and receivable too high in relation to sales. From customers there were complaints about slow delivery and lack of availability. The sales department was hardly on speaking terms with the production department and with the shipping department, both of which sales claimed, prevented attainment of sales forecasts. Traced back, these complaints were symptoms

of difficulties in scheduling, forecasts of demand, storage, inventory control, shipping, customer service, and other functions.

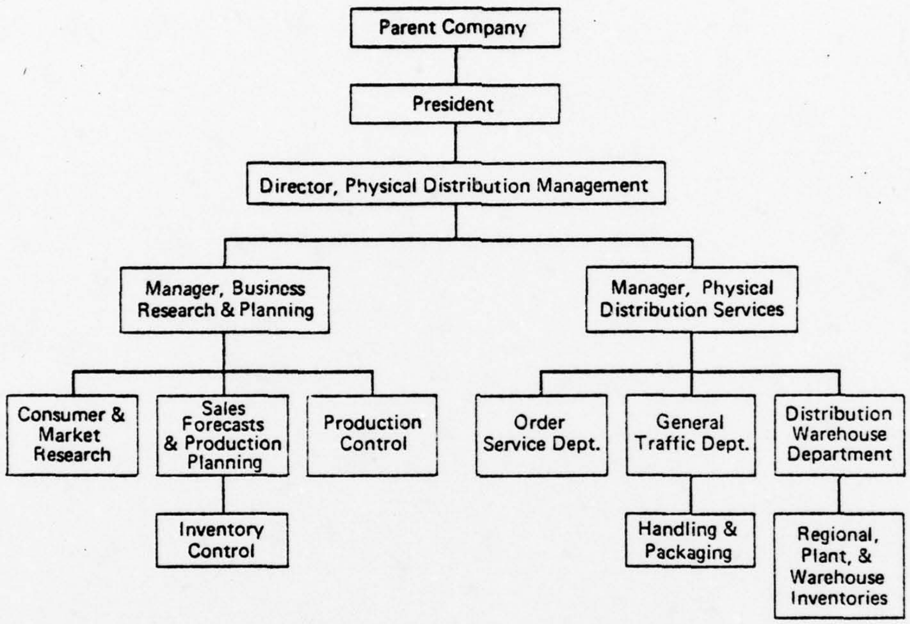

Figure 26. Condensed organization diagram after the reorganization of the management of physical distribution functions at the Norge Division of the Borg-Warner Corporation in 1964 [8;695].

As a result of this appraisal, the organization shown in Figure 26 evolved from that shown in Figure 25.

In commenting on this reorganization, the President of Norge reflected both the pains and gains that accompany organicational reform for logistics management:

> The intervening period contains a certain amount of pain, early retirements, resignations plus reorganizations

> ... there had to be a great deal of persuading and some were not really convinced until Phase One of the program was actually implemented and the results could be recognized by anyone.

The basic source of problems and opportunities in the organization for the management of logistics activities can be traced to the fact that logistics deals with horizontal flows of information and material which do not lend themselves to partition in the form implied by the typical vertical or functional organization structure. An analysis on which organizational change can be based will take into account the importance of logistics activities in the organization, the establishment of the need for reorganization, the identification of activities for which common logistics management is most important, and consideration of alternative approaches to providing necessary communication and coordination of the activities.

The appropriate organizational position for logistics management will depend primarily on the relative emphasis placed on cost control or service performance as a basic objective for logistics operations. Regardless of his responsibilities, a logistics manager in most organizations, to be successful, must play the role and possess the qualities of an integrator.

C. ANALYSIS AND PLANNING FOR LOGISTICS MANAGEMENT SYSTEM

If we want to find a practical way of solving logistics management problems, we should develop a plan of campaign with the structuring of the problems.

We can begin with surveying the environment in which the company is working at the present time, and make clear what developments there have been and what they are expected to be in the future. We further examine interested parties and their relationships inside and outside the logistics system, and should then pay special attention to the development of and collaboration with the transport contractors. In most cases, there is a great potential here for improvements and for an increase in mutual profitability.

When the external environment and its opportunities and demands have been explored, we move on and look at the internal environment with its demands and preconditions. We should then begin to take account of the restrictions which bear on the logistics system and which we must consider when we are planning and designing improved systems. Among the restrictions we find, for example, the service demands imposed on the function by the marketing or production staff, the financial preconditions and the general guidelines established by the company management. The present and future product structure is a very important factor to keep in mind when we are designing the logistics system, since changes in product structure often involve far reaching logistics management consequences.

There are many different approaches for developing a logistics system. One of them, the top-down approach, seeks to develop a model of material and information flow in the organication and to design the LM system to suit this flow. The basic steps in the top-down approach are as follows:

Step 1: Analyze objectives, environments, constraints

Step 2: Identify activities (functions) and define the system

Step 3: Identify decisions and actions

Step 4: Identify types of information needed for each decision and action

Step 5: Group decision and information requirements into subsystems and modules within the subsystems

Step 6: Establish priorities for developing data base and the subsystems and modules.

When approved, this is the master plan. An advantage of this top-down method is its very logical approach to the development of an overall plan. It focuses on the necessity for integration and careful coordination and planning.

Against the background of the general approach for developing a master plan, it may be appropriate to discuss the activities which go into the logistics system from the viewpoint of practical explanation.

In the area of LM planning the following are in most cases included:

* logistics control
* production control
* purchasing
* good reception
* stores and stockholding
* inventory control

* internal and external transport
* delivery service
* orders and invoicing, together with overlapping system development and rescource planning for logistics management.

This means exploring where, by whom and how these activities are carried out, and what opportunities for coordination exist. Before we can do this we must establish what we include in the different activities.

By logistics control we mean here the measures for securing the to-and-from transfer of materials, half-finished goods, components and finished products of the right quality and quantity at the right time and the right place. Starting from the demand forecast and the sales plans connected with them, we build up delivery, manufacturing and supply plans. This, of course, involves taking account of the stock position when working out delivery plans and seeing that "surplus" requirements go forward to the producing function. In the same way when we are working out the manufacturing, we take account of the stores position and requisition "surplus" requirements via the supply function.

Logistics control is closely connected with production as well as marketing and purchasing planning. Production control means here the coordination of the means which make possible the process of production. The purpose is to ensure that the product is delivered in predetermined quantities and qualities at given times and with the lowest possible financial outgoings.

Production control plays an important role during logistics control. The information flow to the production planning system is composed of sales and delivery plans based on forecasts, and/or of delivery plans based directly on customer's orders. When working out the logistics system it is very important that we distinguish between these two main types of production, since their demands on the logistics function are quite different.

It is important that we, from the LM viewpoint, distinguish between master scheduling and detailed scheduling. Master scheduling determines how many units shall be produced, on what time program production shall take place, and what materials, components and half-fabricated goods are required. On the other hand, detailed planning is concerned with allocating the work to machines and people in such a way that specified quantities and time conditions laid down by master scheduling are met.

Lack of understanding of the distinction between master and detailed schedule has sometimes caused organizational problems when the LM concept has been applied. Indeed, in many cases we can with advantage integrate master scheduling, in a materials department, to obtain the close coordination of logistics control which is called for, whereas detailed scheduling is a purely "internal" task in the production function.

The stores planning function must keep detailed records of materials, half-fabricated goods and components used in the company. The records include the present store levels as well

as undelivered orders. Periodic physical inventories must, of course, also be made to verify the records. The stores function is responsible for both direct materials and products, that is, those which go into the final product, and for indirect materials such as tools, office fittings, maintenance/ repair and operating equipment. We must also have routines inside the stores planning function for physical stores holding and for dispatch of requisitions to the purchasing function when ordering points are reached or when special requirements arise.

In a similar way, the stock planning function is responsible for the control of finished stocks and for the connection with marketing and production.

In the last few years, transport planning has become of increased importance for the profitability of the company and its capacity for progress, and this makes increased demands for combined planning and coordination of transport. Improved coordination of transport to and from the company can, in many cases, give very good returns. Incoming transport is frequently bought by a function other than that which buys outgoing transport, and this can cause unnecessary expense if coordination is neglected. Groupage of outgoing goods can also in many cases be improved by relatively simple means. Costs can also be decreased and sales increased by improved coordination of the transport-, stores- and stock-planning functions. Increased costs arising from the use of more rapid means of transport may give reduced total costs through decreased stores and warehouse costs and/or increased service. When assessing

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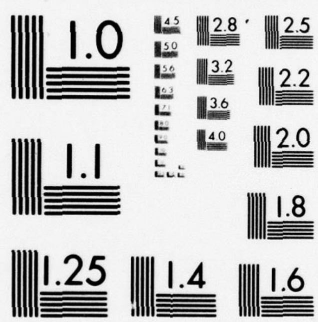


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

different means of transport and transport contractors, we must take into account not only the speed of the transport but also its frequency.

The materials handling function is mainly occupied with the internal movement and custody of materials and products. The reception function is responsible for the physical handling of incoming goods. It must identify the goods, check them against quantity and possibly quality, and move them to the place where they are to be used or stored. Among the tasks of the dispatch function are packing the final product, labelling the goods with shipping instructions and delivering them to the transport contractors.

The activities discussed have all, both a planning function (which has been our main concern) and a purely physical, implementation function.

When we analyze problems of logistics management, we must clearly distinguish both these dimensions. The problem is to make clear both the physical flows and the conditions attached to them as well as the administrative flows and their assumptions. We begin by surveying the physical stores and stocks location, ingoing and outgoing flows, possibilities of building extensions relative to the land available, future environmental requirements and so on.

In the administrative survey we map the information and decision systems. We ascertain who requires various kinds of decisions, to what information the decisionmaker has access, to what information he ought to have access, and how he can obtain this information in the most suitable way.

When we are mapping the information system, we can usefully begin with an activity list, which embraces the whole chain from receipt of order via delivery date, order book records, order raising, fixing of time and quantity for manufacture and for purchasing, preparation of purchasing orders, drawing up of purchasing orders, negotiations with buyers, specifications, supervision of deliveries of incoming goods, goods identification and goods checking, invoice checking, quality control, stores holding, issue checking, stores records, machine cover, ordering, replanning, manufacturing checks, stocks records, warehousing, fixing of transport and timing, delivery instructions to warehouses, packing, preparation of dispatch notes, loading, supervision of delivery and preparation of invoices.

An analysis of delivery timing will show that the information we require in order to be able to make decisions, is a copy of the order from order reception, information on quantities in stock, actual and planned quantities in manufacture, reserved quantities and lead time in manufacture.

By personal interviews we investigate whether the decision maker has this information available to him and, if so, how he uses it. In cases where the decision maker does not have access to the information, we investigate the best means of giving it to him.

We go through all the activities in this way and so obtain a clear picture of the deficiencies which exist in the information system. This survey makes clear both direct connections

between activities, for example that we use reception reports from the activity "goods identification" as the basis of the activity "invoice checking," and indirect connections, for example that when we draw up purchasing orders and specifications, we use current information on suppliers and articles.

The analysis outlined above forms a good foundation for building information and decision systems. We begin by grouping the activities in such a way that the decision points with a common data base are combined into decision centers, and these in their turn are divided up in a suitable manner. An important foundation for division is, of course, the question of whether the activity shall be attached to the logistics function or to some other top function.

By this procedure we arrive at a logically constructed outline for a control system, which is afterwards developed further and refined simultaneously with the adaption of the organization structure. The important point in this further development is to set down accurately what information is actually required at the various decision points so that we avoid the unnecessary spread of information. In some cases in companies, so much superflous data has been sent out in pure "computer emphoria" that relevant information has been hidden or simply drowned. The information must be tailor-made, and we must avoid bombarding decision makers with unrefined and uninteresting data.

It is clear from what we have said that we can find many different solutions for LM problems, depending on preconditions in the company.

One solution is to have physically widespread stores and stocks (for example in various divisions) which are entirely directed from one central logistics function. This means that the logistics function is working with a base of clearly defined service requirements from production and marketing, but itself decides how much shall be held in stock, when and in what quantity requisitioning shall take place, and how handling shall be carried out in a purely physical way.

Another solution is that the central LM function only has decision authority over the purely physical handling of goods, while the contents of the warehouses and stores are decided by the production and marketing managers.

A third solution is to have concentrated stocks and stores which are entirely controlled by a central LM function, or else which are controlled centrally only as to physical handling, while the contents (the volume) are determined by, for example, division managers.

There is, of course, a large number of combinations and the choice must be based on an accurate investigation of the physical and administrative requirements of the logistics system and the preconditions in the particular company. There are indeed no patent solutions to these problems.

D. TOTAL COST ANALYSIS

Total cost analysis is as its name implies, the analysis of logistics systems taking into consideration all logistics costs affected by a proposed change in the system.

Total cost analysis can take any variety of forms, ranging from a listing of cost estimates valid for any point in time to the construction of elaborate models based on observed input-output relationships. Basically, whether dealing with a simple tabulation of costs or a more complex model, we can identify cost, inventory, or other input elements as fixed or variable with changes in volume of sales, distance of movement, size of order, or some other dimension. So-called $y = a + bx$ relationships, where y represents a total cost, a the fixed portion of the cost regardless of changes in the variable x, and b the cost per unit of x or the variable portion of our cost structure, are convenient to construct for logistics system analysis, regardless of the complexity of the approach used.

They make it possible to employ more powerful analytical techniques, such as linear programming, in the analysis by using only the variable portion of the cost estimate in the model itself and factoring into the calculation manually the fixed changes, particularly where such changes are relatively small. And they often describe quite accurately a variety of such relationships.

A classic example of early thinking regarding total cost analysis can be provided by a company called Brunswick Floors, Inc., a company distributing finished decorative wood products from its plant at Brunswick, New Jersey to, among other places, the distribution center which it leases and operates in San Francisco. (This example is written by J. L. Heskett,

N. A. Glaskowsky, Jr., and R. M. Ivie, "Business Logistics," The Ronald Press Company, 1973.)

The executives of the company had gathered cost data and prepared estimates which indicated that a change from the use of rail transportation to either truck or air transportation, and a considerable reduction of the sizable quantities of inventories at both Brunswick and San Francisco could provide total cost savings. Questions were raised regarding the quantity of such savings at the current volume of business (280,000 pounds per year) and the stages in the development of the company's San Francisco regional market at which each combination of transportation and warehousing alternatives would be most economical.

Cost information is shown in Figure 27. Once costs are stated in terms of fixed and variable components in the form of $y = a + bx$ equations, they can be estimated for further volume of business by graphing them as shown in Figure 28, for systems utilizing air and truck tranportation.

Comparing alternative methods graphed in Figure 28 or described in Figure 27, we can set the total costs of any two (y_1 and y_2) equal to each other to find the point of volume (x), if any, at which the total cost lines described by the function intersect. This produces the following result:

$$a_1 + b_1x = a_2 + b_2x, \text{ thus } x = \frac{a_1 - a_2}{b_2 - b_1}$$

Further, we can be sure of computing least-cost line intersection if we rank the alternatives in terms of the amounts of fixed costs incurred under each, from the smallest to the largest. In the example, annual fixed costs for air = \$34,680, truck = \$69,380, and rail = \$84,280. In order to find the first pertinent least-cost line intersections, we would compare air with the truck. In this case, our computations would be based on the following information from Figure 27:

a_1 = \$34,680, b_1 = \$0.25 a_2 = \$69,380, b_2 = \$0.138

For the example in question:

$$x = \frac{34680 - 69380}{0.138 - 0.25} = \frac{-34700}{-0.112} = 309{,}010 \text{ lb.}$$

Cost Item	Method of Transportation, Warehousing: Air	Highway	Railroad
Fixed costs:			
Fixed cost element, freight bill	\$ 5,000	\$15,000	\$15,000
Warehousing, Brunswick	14,680	14,680	14,680
Warehousing, San Francisco	–	14,700	29,600
Total fixed	\$34,680	\$69,380	\$84,280
Costs variable with volume:			
Freight cost element, variable	\$70,000	\$18,000	\$ 7,000
Local delivery, San Francisco	10,000	10,000	10,000
Brunswick warehousing	4,100	4,100	4,100
San Francisco warehousing	–	8,200	12,300
Order preparation and placement	9,250	2,250	2,250
Capital investment in inventory	3,300	6,000	7,800
Product obsolescence and damage	2,480	5,200	2,480
Insurance	620	1,010	1,300
Taxes	420	560	650
Total variable	\$100,000	\$55,320	\$47,880
Annual volume (pounds)	400,000	400,000	400,000
Variable cost per pound	\$.250	\$.138	\$.119
Total cost per pound	\$.337	\$.312	\$.330

*Each of the three systems under comparison provides the same level of service to customers: 30% of all orders delivered within 72 hours of order receipt, 80% within 96 hours; and 90% within 120 hours.

Figure 27. Annual total logistics costs, current and proposed systems, San Francisco Region, Brunswick Floors, Inc. [8;532].

In other words, at an annual volume of 309,010 pounds, it would be economical in the long run to switch from air to truck. This essentially is the same result shown in Figure 28, although the latter is less accurate unless graphed with extreme precision.

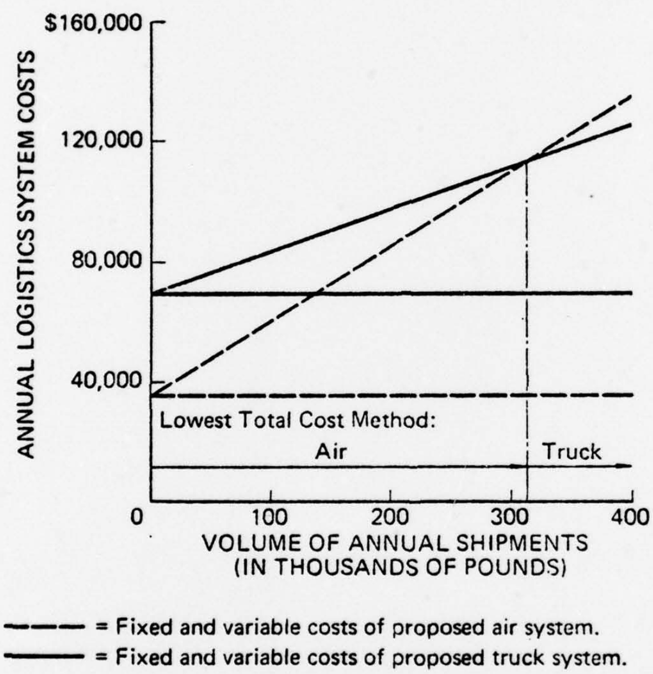


Figure 28. Graphic method of total cost logistics systems analysis, San Francisco Region, Brunswick Floors, Inc. [8;533].

What we have just considered is an abstraction of a complex total cost analysis useful for illustrating the concept. In an actual situation, cost and activity relationships which must be identified and measured in a comprehensive system analysis include those shown in Figure 29. Here we have set

Cost Categories	Vary With:	Which Vary With:	Which Vary With:
Transportation costs per unit	Shipment size	Number of stock locations Frequency of shipment Total volume	
	Shipment distance	Number of stock locations Geographic market coverage	
	Costs of various modes of transportation	Value of product Density of product Geographic shipping patterns Regularity in availability of freight Shipment size	
Warehousing costs per unit	Method of warehousing	Volume of throughput Constancy of volume of activity Physical size of inventory	
	Volume of throughput	Number of stock locations Size of territory served	
	Inventory turnover rate	Inventory policy Volume of sales per SKUL*	
Inventory carrying costs	Inventory control, forecasting method	Pattern of demand Predictability of demand Desirability of routinizing replenishment procedures	
	Order-cycle length	Method of transport Order-processing procedures	
	Volume of sales per SKUL*	Product-line policies Engineering standardization	
	Replenishment shipment size per SKUL*	Sales volume Frequency of replenishment	
Order processing costs per unit	Number of line items per order	Size of product line Nature of market	
	Average order size	Quantity discount incentives Nature of use	
	Method of order processing	Volume of orders	
	Rate of initial order fill	Accuracy of inventory data file Inventory coverage policy	
Lost sales costs	Willingness of customers to substitute	Nature of competition Type of customer need	
	Rate of contribution on sales	Ability to differentiate product, service from competition	

* SKUL = STOCK-KEEPING UNIT LOCATION

Figure 29. Some of the interrelationships in a comprehensive logistics system analysis [8;534].

forth major logistics cost areas and have attempted to identify the major determinants (and determinants of determinants) of each.

For example, transportation costs per unit vary inversely with shipment size, directly with shipment distance, and in relation to the costs of the various methods of transportation utilized. Shipment size, in turn, largely varies directly with the total volume of business, other things being constant. It varies inversely with the number of stock locations and the frequency of shipment, again assuming volume and other characteristics constant.

If we were to fill in the far right column of Figure 29, we might conclude that the total volume of business, among other things, is influenced by the level of logistics service mentioned elsewhere in the figure. Likewise, the number of stock locations will vary with the desired customer service level, which depends on other factors. If the tabulation was developed out to the right, the interrelationships in a logistics system would become more and more apparent.

Clearly, even a comprehensive system analysis must limit itself to an accounting of only the major influences on cost and service. And the task of data collection and revision to fit an analytic format, even with these types of simplification, can be tough and expensive. If carried out properly, however, it can yield relatively accurate estimates of the cost trade-offs under various alternative

system designs. Before turning to methods for achieving this type of result, it is useful to consider some recurring patterns of such cost trade-offs.

A number of logistics system changes are listed in Figure 30. They have been placed opposite the various kinds of costs with which they are associated in vendor, company, and customer organizations. Each example of change, based on actual industry experience, has resulted in the reduction of certain costs of logistics and an increase in others. In a sense, cost increases are traded for cost decreases presumably when a net gain results to the company instituting the change. This exchange has become more popularly known as the "trade-off" of one cost for another.

Consider example 5, where change is represented by an increase in the use of "split shipments" to provide better supply service to the manufacturing line. That is, in circumstances where planned transportation services do not appear likely to meet the time requirements for the provision of supplies or components to the manufacturing line, a part of the shipment is split off and shipped by faster or more dependable methods. This is likely to result in increases in transportation costs from the vendor to the company's manufacturing facility, and order-processing costs of both the vendor and the company under consideration. At the same time, however, inventory holding costs of both the vendor and the company are likely to be reduced. More important, an interruption of manufacturing processes, with the attendant possibility of a customer backorder situation, will be avoided.

These costs often are changed	As this action is taken											
	1	2	3	4	5	6	7	8	9	10	11	12
Long-Distance Transportation From:												
Vendor to Facility[a]		-[c]		+[d]	+							-
Intra-Facility	-	+					-	-	-			
Facility to Customer	+			-		+	-	-				+
(Nature of Cost):												
For-Hire Carrier Charges	+											
Private Carriage Costs												
Local Delivery At:												
Origin(s)												
Destination(s)										-		
Material Handling:												
Vendor		-										
Company[b]	-	-				-				-		+
Customer						-						
(Nature of Cost):												
Equipment	-					+						
Labor	-					-						
Supplies	-					+						
Inventory Holding In:												
Vendors' Facilities		+	-		-							
Company Assembly Warehouses		+	-		-							-
Company Factories					-			-	-			+
Company Distribution Warehouses	-			+				+	+		-	+
Customers' Facilities	-			-				-			-	
Carriers' Equipment (En Route)	-						-					
(Nature of Cost):												
Interest on Investment												
Obsolescence									-			
Pilferage and Damage							-					
Inventory Taxes										-		
Insurance												
Rehandling									-			
All of the Above	-[c]	+[d]	-		-						-	
Warehousing:												
Vendor		+										
Company Assembly[b]		+	+		-							-
Company Distribution	-			+		-		+				+
Customer	-			-		-		-				
All of the Above												
(Nature of Cost):												
Fixed – Private Facilities[a]										-		
Variable – Public Facilities										+		
Packing:												
Vendor Packing		-	+				+					
Company Unpacking – Packing						-	+					
Customer Unpacking	-					-	+					
Order Processing:												
Vendor		-	+		+							
Company	+	-	+		+						+	
Customer	+											
Manufacturing (If Applicable):												
Fixed					-							-
Labor Variable			+									-
Equipment Variable												-
Sales Losses Due to Logistics:												
Customer Service Deficiencies				-	-		-	-	-		-	
Market Territory Restrictions	-			-			-	-			-	

1. Use of premium methods of transportation for outgoing finished products (accompanied by a reduction in warehouses, overhaul of communications).
2. Purchasing and shipping supplies and components by means of fewer orders of greater quantity.
3. Consolidation of shipments from supply points (allowing smaller, but requiring better timing of, purchases).
4. Increase in the number of distribution warehouses (reducing service times to customers).
5. Increase in the use of "split" shipments on supplies to meet manufacturing requirements.
6. Change from hand methods to palletization in handling of finished product (requiring customer compatibility for optimum savings).
7. Increase in the protective characteristics of packing containers (allowing shipment under different freight classification).
8. Establishment of distribution warehouses as mixing points for shipments between plants and customers (allowing volume shipments to customers).
9. Shifting packing and/or packaging operations from plant to distribution warehouse (allowing shipment in bulk).
10. Use of public vs. private warehousing facilities.
11. Use of faster communications and mechanized procedures in handling orders from customers.
12. Stabilization of labor requirements for manufacturing by establishing constant production schedule (creating inventory level fluctuations).

[a] Facility (plant or warehouse) of the company whose procedures are under study.
[b] Company taking the action.
[c] Costs which are reduced by the action.
[d] Costs which are increased by the action.

Figure 30. Examples of logistics trade-offs reported in actual situations [8;536].

Identification of the nature of logistics and cost trade-offs is a function of time and of the objectives of the system in which change is proposed. Time is important in establishing the relevance of change in a system. In example 4 in Figure 30, for instance, the propriety of an increase in the number of distribution warehouses would be based on the number and location of those already in operation in relation to company markets and manufacturing facilities. If a high degree of customer service were already being rendered by the system, the cost trade-off would take on primary characteristics of an increase in warehousing and inventory holding costs for a reduction in transportation cost from warehouse facilities to customers. Given a point in time at which customer service levels were relatively low, the trade-offs would include gains from an improvement in customer service.

The objective of a given system further determines the nature of cost trade-offs in a logistics problem. For example, two basic objectives might have prompted the action in example 5 of Figure 30: (1) improvement of service to the manufacturing line and hence to customers, or (2) maintenance of the current level of service to the manufacturing line and to customers with some reduction in total logistics costs. Given the first objective, the cost trade-offs are essentially those pointed out above. The presence of the second objective, however, would simplify the nature of the trade-offs to an increase in inbound transportation costs for a reduction in inventory holding and warehousing costs.

Total cost analysis of logistics systems may be accomplished by a series of intuitive probes or by more formal operations research techniques. The most successful efforts often result from a combination of the two approaches.

Questions can be raised which help bring order out of the jumble of information collected concerning a logistics system. Further, the responses which they produce can provide direction for the selective application of more formal, often more expensive operations research techniques. The following list is not exhaustive, but should suggest other, similar questions. Many of these intuitive probes implicitly honor such time-worn shibboleths, rules of thumb, or heuristics as: (1) reduce the greatest element of cost, (2) minimize handling, or (3) maximize freight consolidation. In practice, however, it is often found that the most cost-, service-, or profit-elective system does not minimize or maximize any single characteristic but strikes a balance between sometimes conflicting rules of thumb.

Priority attention to the largest or fastest growing cost items. One way of developing an analytic strategy is to identify the largest or fastest growing item of cost in the logistics system and attempt to reduce it.

Measurement against standards - System performance can be measured against standards, reflecting both system inputs such as cost budgets, and system outputs, including customer-service and other performance standards, competitor's performance, or industry averages.

Review of the total transport-inventory cost mix. Adjustments should be made in the well-managed systems to bring transport and inventory costs into a total cost equilibrium.

Appraisal of opportunities of economics of scale through consolidation. Consolidation of shipments, inventories, or orders can result in significant economics of scale in a logistics system.

Review of system effectiveness in assorting and sorting. Closely allied to questions of consolidation are those concerning product handling, typically to meet the needs of related organizational entities for different assortments of components, raw materials, and finished product.

Evaluation of commitment delay. To what extent does the system allow for the replacement of finished items in inventory with semi-assembled components, each for use in multiple finished items? To what extent does it delay shipment in the relation to the receipt of an order? To what extent does it delay the commitment prior to sale of standard components to separately defined stock-keeping units, or even better, stock-keeping unit locations?

Provision for product and market differentiation. Are there potential cost reductions inherent in a differentiation of logistics practices for various products, portions of a product line, on markets? To what extent does a system under examination reflect such differences?

Provision for system balance. To what extent are system elements, indicated by their performance, compatible with one another?

What use would, for example, a rapid communication for customer orders serve in controlling inventories if the resulting update of inventory files from such information were to be delayed until after 2 matching documents had been received by mail from 2 different sources?

The wide variety of analytic techniques appropriate for logistics system design can be categorized rather simply. First, all techniques serve either to optimize or simulate a given situation. Second, all of them can be categorized basically as falling into two families, according to the nature of the problem which they address: location or inventory control.

Typical of the optimizing techniques are linear programming and inventory models. These techniques provide "the one best" answer, an optimum solution of a problem for which a specific objective function has been stated, most often in terms of minimization of transportation, production, or total costs, or maximization of profit. Further, the economy of problem statement and the power of the mathematical approaches possible for optimizing techniques usually allow their use at a much lower cost for computing time than for simulation models, at least at the current state of the computing art. Problems involving up to several hundred origins and destinations can be solved for example, by linear programming techniques in just several minutes of computer time.

As we know, however, optimizing approaches such as linear programming tend to oversimplify the problem statement. The range of costs and activities which can be included in such analysis is extremely limited. In addition, they require the use of restrictive assumptions. An illustration of this is the assumption of cost linearity regardless of volume in linear programming. Although there are ways of dealing with some of these restrictions, overall they constitute significant compromises for many applications.

In contrast, simulation techniques provide relative freedom of problem expression. Whether dealing with location or inventory problems, simulation techniques emphasize a more detailed, accurate description of the way in which problem elements interact. For example, rather than emphasizing the calculation of the optimum inventory management rules, simulation techniques would attempt to describe the receipt and shipment of orders and related activities in such a way that various inventory management rules could be imposed and the resulting costs and service measures compared under various sets of rules.

Clearly, simulation techniques allow for the inclusion of more types of costs or physical activities in an analytic model. For this reason, they have broad application to a wide range of problems.

To the extent that the practical application of simulation prevents the explicit description of all elements of a system, certain simplifying assumptions or calculations are included

even in large-scale simulations. To the extent that they are necessary, they reflect the views of the model builder, views which may or may not reflect reality. Perhaps the biggest drawback of simulation approaches is that they do not provide "the one best" answer. In fact, they neither provide any guarantee that the best answer will be found nor give any indication that the best answer has been found. In a sense, they leave more to the imagination and creativity of the user, a feature that managers may find either attractive or unattractive. A third major problem associated with many large-scale simulations is the large amount of computing time and expense they require for just one iteration of a problem.

With the continuing development of analytic techniques, comprehensive logistics system analyses are becoming more and more feasible. To date, no truly comprehensive model spanning location and inventory problems has been developed which relies solely on optimizing techniques. The greatest progress has been made in the simulation of logistics systems of larger scope.

Even with the availability of a growing portfolio of techniques, effective system analysis still relies on a combination of good common sense and the knowledge of when more formal approaches will and will not work.

E. THE DEVELOPMENT LIFE CYCLE

The basic idea of the development life cycle is that every application needs to go through essentially the same process when the application is conceived, developed and implemented.

Therefore, neglecting any portion of the life cycle activities may have serious consequences for the end result.

LM systems development involves considerable creativity; the use of the life cycle is the means for obtaining more disciplined creativity by giving structure to a creative process. The life cycle is important in the planning, management, and control of logistics systems application development. The use of the life cycle concept provides a framework for planning the individual development activities. If an application cannot be planned as activities in the development life cycle, it probably cannot be accomplished at all. In order to manage and control the development effort, it is necessary to know what has been done, and what has yet to be accomplished. The phases in the development life cycle provide a basis for this management and control because they define segments of the flow of work which can be identified for managerial purposes and specify the documents to be produced by each phase.

The steps or phases in the life cycle for system development are described differently by different writers, but the differences are primarily in amount of detail and manner of categorization. There is general agreement on the flow of development steps and the necessity for control over the development cycle.

The system development cycle consists of 3 major stages:

* Definition of the system or application
* Physical design
* Implementation

In other words, there is first the process which defines the requirments for a feasible cost/effective system. The requirements are then translated into a physical system of forms, procedures, and programs; by system design, computer programming, and procedure development. The resulting system is tested and put into operation. No system is perfect, so there is always a need for maintenance changes. To complete the cycle, there should be an audit of the system to evaluate how well it performs and how well it meets cost and performance specifications. The 3 stages of definition, physical design, and implementation can therefore be divided into smaller phases as follows:

Stage in life cycle	Phase in life cycle	Rough percentage of effort	Range in percentage of effort
Definition	Feasibility assessment	10	5–15
	Information analysis	15	10–20
Physical design	System design	20	10–30
	Program development	25	20–40
	Procedure development	10	5–15
Implementation	Conversion	15	10–20
	Operation and maintenance	(Not applicable)	
	Post audit	5	2–6
		100	

Figure 31. The system development life cycle [9;415].

The systems development cycle is not followed in 1, 2, 3 fashion, reference Figure 32. The process is iterative so that, for example, the review after the system design phase

may result in cancellation or continuation, but it may also result in going back to the beginning to prepare a new design.

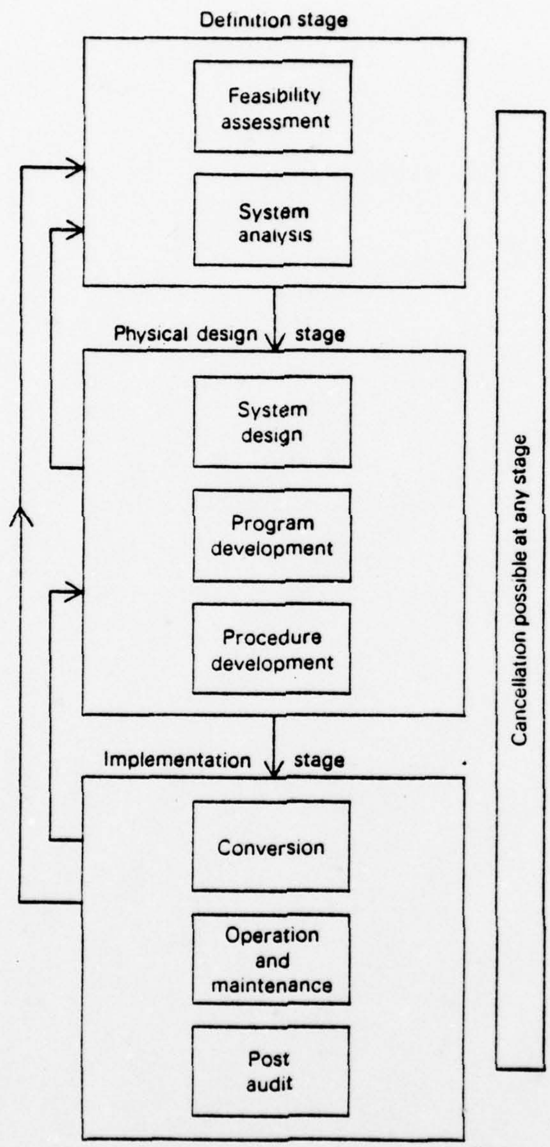


Figure 32. The system development life cycle [9;416].

Each phase in the development cycle results in documentation. The sum of the documentation for the phases is the documentation for the application. The amount of detailed analysis and documentation in each phase will depend on the type of application. For example, a large, integrated application will require considerable analysis and documentation at each phase; a report requested by a manager will require little analysis and documentation, but all the phases are still present.

Note that the system development life cycle does not include the selection and procurement of equipment. The reason is that such equipment is generally related to many systems rather than a single application. But if an application requires equipment selection, this will generally take place during the physical design development stage.

The percentages presented in Figure 31 provide a rough idea of the allocation of effort (say, man-hours) in the system development life cycle from inception until the system is operating properly (i.e., excluding operation and maintenance). These percentages will, of course, vary with each project. The ranges shown are indicative of the variations to be expected.

Definition Stage

During the definition stage the project is proposed, a preliminary survey is prepared, and the feasibility assessed. If the project is deemed feasible and is approved, the next phase is the preparation of information and information flow

requirements. A project may be a module defined by the master development plan, a major maintenance project, or a project allowed but not scheduled in the master plan.

After the project or problem is proposed, the first step is to define the problem. An analyst is assigned to work with the potential users and prepare a report describing:

* the need for the project (a problem, opportunity for savings, improved performance, etc.)
* the expected benefits (in very rough form)
* the outlines of a feasibility study (objective, time required, and resources required).

The proposal report is reviewed by the department proposing the project, the system executive, and the planning committee. If the project definition is approved, the feasibility study is begun.

One or more analysts conducts the feasibility study which is to assess three types of feasibility:

1. Technical feasibility. Is it possible with existing technology?
2. Economic feasibility. Will the system provide benefits greater than the cost?
3. Operational feasibility. Will it work when installed?

The objectives of the system are amplified from the rough objectives in the feasibility study proposal and the following are prepared:

* Rough outline of the system
* Development work plan

* Schedule of resources required for development

* Schedule of expected benefits

* Project budget

The feasibility report is reviewed by top management, system executive, and by the requesting department (the user). If not part of the master plan (and of significant impact), the project will need to be reviewed by the systems planning committee. If the project is approved, the next phase is system analysis.

One or more information analysts (or systems analyst if no distinction is made between information analysts and system designers) are assigned to the project. The analysts work with users to define the requirements in detail and to define the information flow as well as the physical flow. The results of the information analysis phase are:

1. Layouts of the outputs
2. Layouts of inputs
3. Data definitions for required data items
4. Specifications regarding information such as response time, accuracy, frequency of updating, and volume.

These specifications complete the definition of what the system is to do; the next step is to design the processing system to produce the results as defined.

Physical Design Stage

The physical design stage begins with the system design. This is the design of the processing system that will produce the reports/outputs specified in the system analysis. It

designs the equipment usage, the files to be maintained, the processing method, and flow of processing. The results of the system design phase are:

* File design layouts and specifications
* System flowcharts showing, for example, use of equipment, flow of processing, and processing runs
* Control flowchart showing controls to be implemented at each stage of processing
* Backup and security provisions
* A system test plan
* A hardware/software selection schedule (if required).

The programming and procedure development phases can proceed concurrently. Programmers will be assigned to do the programming; analysts will normally prepare the procedures. The programming phase uses the system specifications from the system analysis and system design phases to define the programming task. A program plan is prepared which breaks the programs into modules and specifies interfaces among the modules. Documentation is completed and assembled. The result of the programming phase is a set of tested programs that are fully documented.

Procedure development involves the preparation of instructions for the following:

1. Users
2. Clerical personnel providing input
3. Control personnel
4. Operating personnel.

The procedures are written; tested for completeness, clarity, and ease of use; and reproduced for distribution. The procedure development phase can also include the preparation of training material to be used in implementation.

Implementation Stage

When the programs and procedures are prepared, the conversion phase can begin. Data is collected, files built, and the overall system tested. There are various methods of testing. One is to test the system under simulated conditions; another is to test under actual conditions, operating in parallel with the existing systems and procedures. It is generally considered not good practice to implement a complex system without one of these full system tests.

After all errors and problems that have been detected in the system test are corrected, the system is cut over into actual operation. When it appears to be operating without difficulty, it is turned over to the maintenance group. Any subsequent errors or minor modifications are handled as maintenance. Because of the importance of maintenance, it is important that the system be designed and documented for maintainability.

The last phase of the implementation stage is a post audit. This is a review by an audit task force (composed, for example, of a user representative, an internal auditor, and a data processing representative). The audit group reviews the objectives and cost/benefit representations made in behalf of the project and compares these to actual

performance and actual cost/value. It also reviews the operational characteristics of the system to determine if they are satisfactory. Control and security provisions are examined. The results of the post audit are presented in a report. The recommendations are intended to assist in improved management of future projects, improvements in the application under review, or cancellation of the application if it is not functioning properly.

F. A SYSTEMS APPROACH TO LOGISTICS ORGANIZATION

Even though there exist basic guidelines for system development in general, there are no clear-cut rules or guidelines to help one design and implement a logistics department using the systems approach. The process of developing the organization will often go hand-in-hand with designing the logistics system hardware/software (warehouses, computers, trucks, order processing systems, etc.). But one cannot simply add people to the "hardware/software" and begin operations. Though the system's physical components have been designed and can be treated as a "given" structure, an organization must be built around the hardware/software.

Systems design begins with top management's stated goals, translated into a set of logistics objectives for the LM system in the form of delivery times, inventory levels, logistics costs, etc.

The second step in the design stage is to relate the given resources and hardware to the environment. Environmental factors consist of such items as:

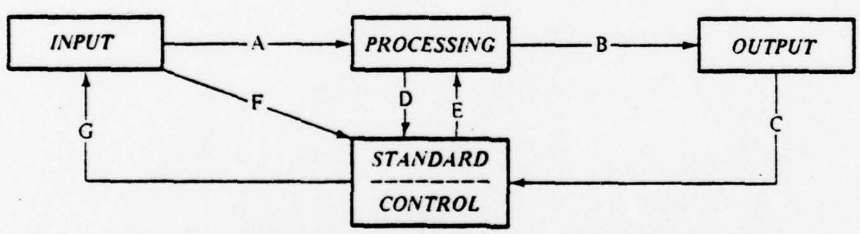
1. trade channel alliances
2. economic conditions
3. exchange channel alliances
4. competitive tactics
5. network of service industries
6. government and legal regulations
7. geomarket differentials
8. industry structure

The logistics design can start with the original mission and subtract or add the relevant external factors to arrive at "net" service or cost performance missions for the internal logistics organization.

An example of this analysis includes the quantification of competitive delivery times and subtracting from that amount the speed at which available transportation firms deliver; this determined net figure is the margin within which the firm's logistical system must operate.

The third step converts the key factors determined in step two into activity requirements. This means developing a clear-cut list of activities to be performed by the system. An example: all units of product A sold in the southeast will be (1) produced in the Memphis plant, (2) shipped in carload lots to (3) the Atlanta distribution center. The goods will then be (4) shipped to the customers by trucking firms whose service permits at least 48-hour delivery. Activities then include first of all, warehousing, order processing, unit loading, and shipping.

The fourth step breaks the specific tasks that support the activity requirements into sub-sub-systems. Using the step 3 example, this would mean that the Atlanta distribution center would be sub-system to the firm that would have supporting sub-sub-systems consisting of one warehouse system, a shipping system, an order processing system, etc. This is the most elementary system level. Figure 33 illustrates how the sub-sub-shipping system would apply in this case. Interfacing with this shipping system would be the order processing, storage and materials handling, and sales service sub-sub-system.



INPUT: Machinery to select carrier to move a particular shipment (routing guide, phone, order call).

PROCESSING: Carrier picks up shipment and carries to destination.

OUTPUT: Delivery by carrier.

Link A: time from call to actual pick up

Link B: time and rate for shipment

Link C: cost and service measured against a standard for each movement

Link D: trigger mechanism pinpointing too long a delivery time

Link E: tracing activity

Link G: select or reject carrier for future movements

Link F: determine if shipment is too small or has some other extraordinary characteristic apart from normal procedure.

Figure 33. A basic system element applied to a traffic office [10;276].

It will be noted that the logistics system should be a relatively closed one so that its output can be continually measured and its subsequent input modified to correct deviations. Feedback and control in logistics should be one of management by exceptions, and that management review be limited to deviations from anticipated results. Significant exceptions that are creating a trend, though, indicate the need for system evaluation and possible change.

The fifth step places these system elements into the three-layer management organization scheme consisting of the physical operating level, programmed management and the master planning level. Figure 34 shows how these layers relate to one another.

It should be remembered that because of competitive, productive, and product peculiarities of each firm, and different personalities involved, no two firms (even using the systems concept) will develop similar "optimum" logistics organizations. Further, by its nature as a closed system, the logistics activity must always be on the lookout for and ready to accommodate change. Dynamic factors such as changing market forces and demands, altered production technology, differing information handling techniques, new carrier awareness for shipper-carrier cost-sharing opportunities, changes in product lines, shifting markets, and fluid changes in financial considerations, constantly play on logistics. So the system cannot be built once; it has to be built to accept change both passively and actively.

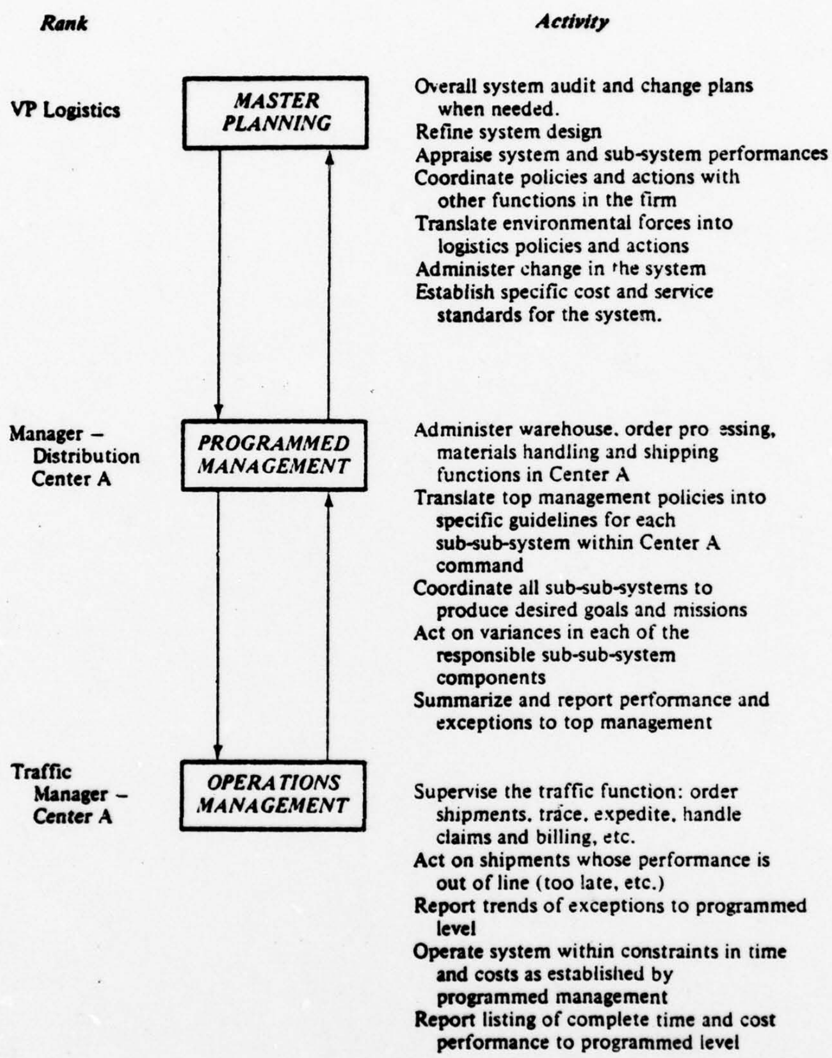


Figure 34. The three-layer organization structure applied to logistics [10;277].

The job of managing the logistics activity is not definable in a concise and clear-cut manner. Where production management is basically defined as that task of administering productive resources in a most efficient manner and under established guidelines, logistics must do much more than administer its own system. Logistics department management must concern itself with such diverse functions as system design and development, physical distribution policy formulation, system administration, coordination with related functions, and public relations and representation factors.

The three-layer framework provides the basic structure and operational activity of the entire organization (reference Figure 34). Starting at the bottom of the organization is the operational (or physical) systems components. These are the most elementary system activities and every one of these tasks (a sub-sub-system) is viewed as having one or more limited goals. The shipping department for one plant may, for example, have four employees. Its inputs are the personnel and facilities used, orders to be shipped, labeling and shipment documentation activities. The processing is the actual shipment, expediting, tracing, miscellaneous carrier contact work, and loss and damage work. The output is measured in terms of tons, shipments or the number of each product units shipped, their total shipment costs plus losses and damages and a realistic allocation of overhead costs attributable to the shipping department (e.g., supervisor's salary, direct phone expenses, floor space costs, supplies and tariff book costs).

The output is measured by feedback reports to the supervisor who is considered the control mechanism. He initiates action on shipments that exceed normal delivery times (tracing and followup), compares actual shipment preparation time and costs (wrapping and overall shipping dock throughput time) against a norm or desired standard (e.g., all shipments take no more than 15 man-minutes to prepare and must clear the dock within the same day). The actual management activity here is very routine in that it is very limited to specific control and administrative activities. Very little managerial discretion is required because for each problem there is a very defined method of approach or solution. The manager's performance is very easy to measure since his job goals are specifically defined.

The second tier of management encompasses that person or group of persons who control and administer two or more of the individual sub-sub-systems. This level would include the manager of an entire distribution warehouse or director of a whole product line. This is the programmed level of management; that is, the control activities are concerned with making programmed decisions on exceptions-problems of the sub-sub-systems. The decisions on this level are also limited in that there is not a wide latitude of discretionary powers resting here. This manager's responsibility is to manage his sector of the firm (several sub-sub-systems) under a stated cost, profit or service constraint. Upon facing a problem of one or more sub-sub-systems (shipping, warehousing, etc.), this manager must take corrective action

and/or initiate investigation to determine the reasons for problem recurrence. His administrative aspects are those of implementing changes in the systems under his jurisdiction, coordinating related functions within and interfacing his overall sub-system, and he might maintain a small support staff whose role it is to audit the sub-system, conduct continual research to refine and adopt the sub-system to change, and to represent the sub-system in dealings with external functions (rate negotiations, etc.).

The top management tier is the master planning level. This is the non-programmed level where very little routine work is done. Input is the performance and exceptions problems of the sub-systems, and factors external to the entire system (competitive forces and other changed environmental considerations). Processing is mostly analytical work, (research and engineering studies). Output is the decisions and orders concerning corrective sub-system actions, or new policies and overall system guidelines, and actions on large distribution system and capital acquisition programs. This level typically consists of a top logistics officer (with a supporting staff of controllers, engineers and analysts who continually audit, consider and plan changes in the system) and members of top management who are concerned with policy matters of the entire firm (overall roles, service, return on investment and corporate strategy).

The management of various activities under one executive is usually the most effective way to manage logistics

activities. When related activities are grouped under one manager, decisions affecting two or more of these activities are more likely to be made objectively with a view toward optimizing total effect on the firm rather than one activity.

G. THE EFFECT OF THE LOGISTICS MANAGEMENT CONCEPT ON TWO COMPANIES

The aim of logistics management is to bring into being an integrated systematic approach to the administration of the materials and information flow from the raw materials supplier to the final user. The flow cuts across both company and department boundaries. This, of course, causes problems.

We shall discuss the problems which arise in the administration of the internal logistics system because of the traditional division of materials activities between different departments. The LM concept is in itself no new organizational concept, but is a systems oriented approach. It may, however, be interesting to look at the purely organizational effect which the application of the approach can have on various companies.

LM has great significance for top management in a company and the concept must be backed up if it is to have the driving forces it deserves. Company managements who wish to profit by this approach must be ready to accept its main message—continuous concentration on flows instead of separate activities. In some cases this may involve restructuring of the previous set-up authority and methods of work.

Two examples of application of the LM concept will now be presented. In the first case the main stress is laid on the external outward flow of materials and information, while the second case concentrates on the inward flow and the internal system.

Both these cases are written by D. Ericsson, "Materials Administration," McGraw-Hill Book Company, 1974.

<u>AB Gulu</u>

AB Gulu has been changed from a company which may be called "traditional," with many of the logistics activities split up between various departments, to an organization with integrated logistics functions. AB Gulu has several factories, some of which are concentrated close to headquarters. There are some two hundred different finished goods which must be distributed from a number of distribution warehouses to wholesalers and retailers around the country. In addition, there is an insignificant export, going direct from the factory to the country of destination.

The inflow is concentrated volumewise on a few bulk goods and packaging materials. AB Gulu is market oriented, even though production plays a large part since the product must be good. Distribution activities have great importance in the company and as an example, it may be noted that transport costs alone make up almost 10 percent of turnover.

In the old organization (see Figure 35) the responsibility for transport was divided as follows:

* The purchasing department was responsible for ingoing transport.
* The transport manager (reporting to the production director) was responsible for transport from some (central) factories to distribution warehouses and a number of resellers.
* Regional factory managers were responsible for transport to distribution warehouses and some resellers. The factory managers also had responsibility for some of the local purchasing and for local stores.
* The financial manager was responsible for transport to certain resellers as well as for transport connected with export.

Buying activities were managed part centrally at headquarters and part locally at some factories. There was, however, no formalized coordination.

Responsibility for physical stores and stocks was divided in the following way:

* The stores manager directly subordinate to the manufacturing director was responsible for central stores.
* Local stores and stocks came under individual factory managers. Responsibility for stores control came under a planning function directly accountable to the production director but without any other formal connection with physical stores.
* The responsibility for the physical distribution warehouses was allocated to a function under the marketing

manager, and control of stocks was allocated to another function (customer service) under the marketing manager.

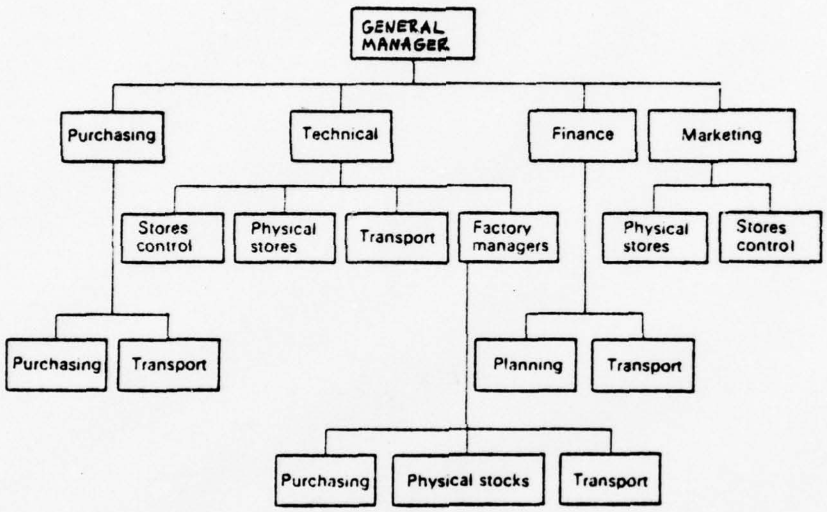


Figure 35. AB Gulu before reorganization [6;152].

The logistics control function was not formalized but was covered by informal committees. The chairman was a planner directly accountable to the finance manager. This function was also responsible for ordering processing. At logistics control meetings people from marketing, production and finance took part but, on the other hand, no one from purchasing. It will be clear from this account that no attempt whatever had been made to coordinate the materials flow and control it globally and this also led to inefficiency, bad customer service and unnecessarily high costs.

The present organization of AB Gulu can be seen from Figure 36.

The logistics control function has been formalized and put directly under a logistics manager. He also has administrative responsibility for all transport activities, for stores and stock control and for central physical stores and stocks. The logistics manager also has administrative responsibility for routine purchasing, while the strategic purchases are placed under a purchasing director, who also has functional responsibilities for the tactical purchases. The logistics manager has functional responsibility for the local materials and production planning functions of the factories and for the local physical stocks and stores.

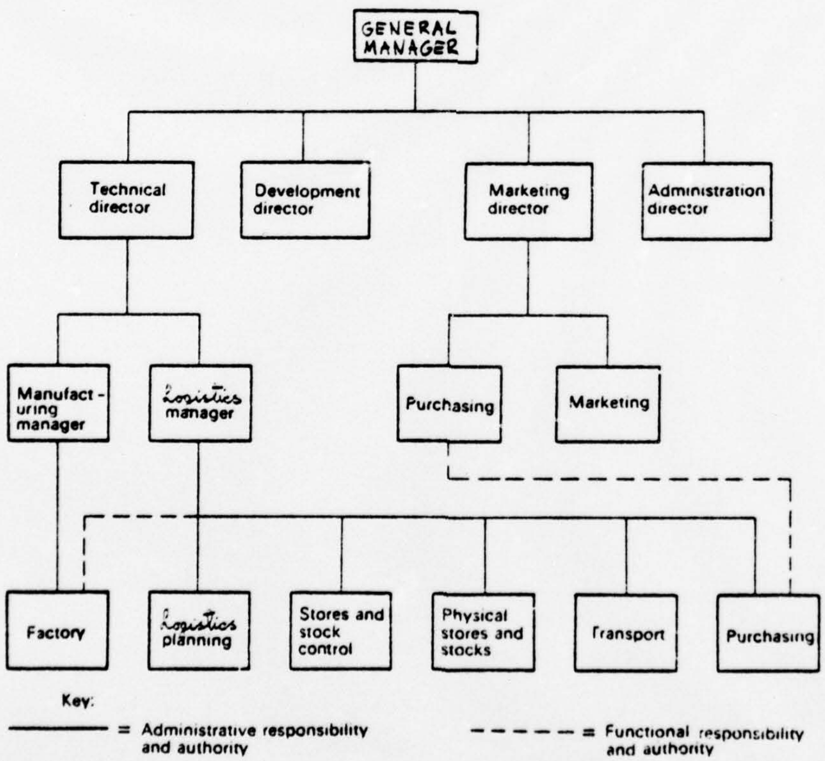


Figure 36. AB Gulu after reorganization [6;153].

The factory managers come under a manufacturing manager, who is on the same level as the logistics manager, and both of these report to a manufacturing and distribution director (technical director). It is the task of the technical director to coordinate production and logistics activities, and he is responsible for developments inside these areas in collaboration with a special development department.

The purchasing and marketing managers report to a marketing director who coordinates purchasing and marketing functions and is responsible for the development of these in collaboration with the development department. The administration director is in charge of the finance, personnel and systems departments and here too there is a close collaboration with the development department. The purpose of this arrangement is both to bring about the necessary research and development in the company and to anchor the development department in practical, "line" activities. In this way the development department has a good overall view of the company and its total activities both long and short term.

Reorganization of this type has demonstrately brought about considerable advantages. It is very difficult to calculate reductions in costs and increase in revenue, especially in a rapidly growing company. It has, however, been possible to reduce the levels of stores and stocks simultaneously with an increase in turnover, and this has resulted in an increase of 50-80 percent in speed of turnover.

It has also been possible to reduce the number of distribution warehouses without any loss in the service level and there is very efficient control and review of stores, production and stocks.

AB Deric

AB Deric is an order-guided company where the production function has decisive importance and where, therefore, the most important logistics activities are found on the inflow side. Distribution outwards is very simple and consists in some cases of the customers coming themselves to pick up their products. There are therefore no finished stock warehouses or other complications. On the other hand, the flow inwards is complex, since the problem is to coordinate the flow up of up to 50,000 different components, half-fabricated goods and raw materials which go into the finished product.

These products, including machinery—equipment and necessary supplies—are requisitioned from several different domestic and foreign suppliers. The individual incoming loads

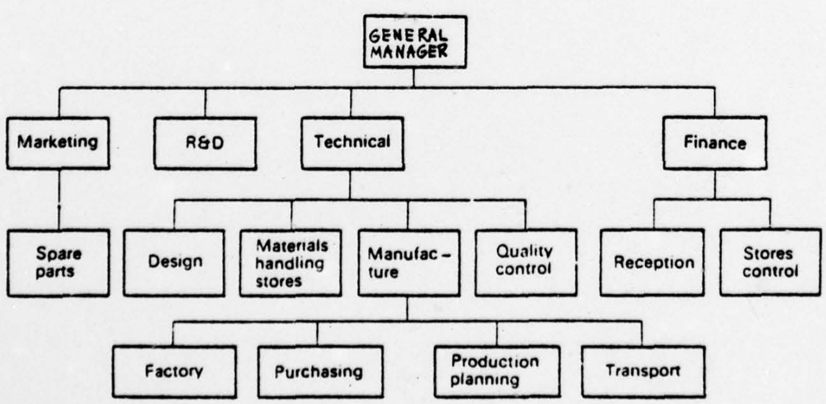


Figure 37. AB Deric before reorganization [6;155].

are frequently quite small, and the attempt is therefore made to use grouped consignments as much as possible.

Figure 37 shows how the logistics activities were split up among different departments in the old organization:

* The marketing department is responsible for the control and physical handling of the spare parts.
* The finance department is responsible for reception and control of the stores.
* The technical director is responsible for the remaining logistics activities.

The managers of design, materials handling and quality control report directly to the technical director while purchasing, production planning and transport, as well as manufacturing, report to a works manager who is directly responsible to the technical director.

During the reorganization spare parts, stores control, reception, materials-handling and quality control were transferred to a logistics department under the technical director. Logistics, design and manufacturing managers are on the same level and report directly to the technical director. Where quality control should be allocated was discussed in detail. The advantages and disadvantages of an independent department and of reporting to the production manager or the design manager were discussed in detail. In the event, the advantages of making the logistics manager responsible for all the quality aspects outweighed the disadvantages. Collabora- with design and production staff is, however, intimate by the very nature of the case.

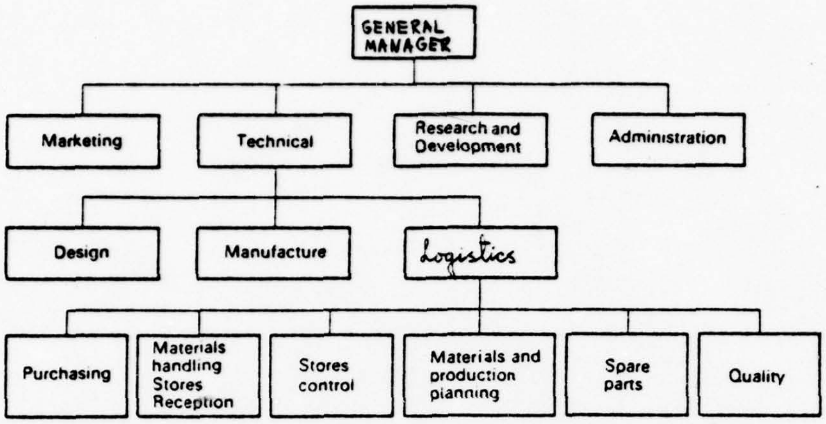


Figure 38. AB Deric after reorganization [6;156].

On the same level as the technical director are the marketing director, the administration director and the development director.

In the new organization we have better coordination and at the same time opportunities for planning and development are increased. By coordination the logistics activities are made efficient. The coordination between purchasing and stores meant, for example, that we could reduce the level of stores, at the same time as lead times were reduced, and saved something like $400,000 a year for the company.

Summary of the results from AB Gulu and AB Deric

AB Gulu may be regarded as a stockguided, strongly customer-oriented company, while AB Deric is an orderguided, production-oriented company.

The companies are therefore at opposite poles from a logistics management point of view. In spite of this, a LM approach to the problem has, in both cases, produced very good

results. In the first case the analysis had to be concentrated on distribution outwards and on the organization problems connected with it, while in the second case we begin with distribution inwards and the internal logistics system. To be able to grasp firmly organizational problems of this type and to bring about solutions which work, we must pay attention to the individual people and groups and their performance. The main thing here is to remember that there are individuals with different behavior, different attitudes, different knowledge and desires.

Communication is the basis for all collaboration both in companies and elsewhere. We must therefore take note that there are communication barriers which must be overcome.

In the company we can distinguish three different group formations, between which communications problems may arise, these are:

* expert groups
* horizontal grpups
* vertical groups

Members of expert groups belong together by reason of common educational background, experience and so on. Members of the group "speak the same language" and have common rules and norms of behavior. Finance men, technical men, systems men and programmers are examples of expert groups. In many cases, therefore, these extend over the traditional departmental limits. Communication difficulties arise here because the different groups have different "languages" and thus terms

and concepts may have different interpretations. This means that when we are doing an organizational analysis (for example in connection with an LM investigation), we must work out a "glossary" which provides a common frame of reference in order that the investigation shall not be stranded on purely semantic problems.

The second type of main group is lined with the traditional organization scheme and the formation of departments within it. We often divide companies into departments to be able to take advantage of specialization. This is based on traditional administration lore, which first and foremost emphasizes the opportunities which will arise by dividing (vertically on different organization levels and horizontally in different departments) and thus creating relatively independent organizational units whose limits of responsibility are clear to each other. In practice, this quickly leads to overlapping and double work, with consequent inefficiency. These negative effects can moreover be strengthened by problems of parochial thinking and communication.

Logistics management is an example of a newer approach, with emphasis on integration, and while we are engaged on organizational analysis, we must be conscious that there may be a hostile situation between advocates of this approach and those of a traditional approach. The problem is to bridge over these conflicts by means of communication and show that it is not a question of either/or but rather one of both/and. We have a great deal to learn from the traditional organization

theory but the problem is to adapt it. The most essential thing is, in the "new" system, to avoid the communication barriers which traditional departmental reasoning often involves.

Vertical division in some ways also coincides with the formal organization structure and its division into different hierarchical levels. On the different levels we make decisions on different time scales and this is as true inside departments as it is, totally, inside the company. (Compare divisions of strategic, tactical and operational levels.) What chiefly interests us here is that the different distances of the planning and decision horizons can cause the problem to be understood in absolutely different ways, even though the objective aimed at is perhaps the same in every case.

A decision on a change in way of production can, for example, be entirely correct in the long term, but even so may be opposed on the tactical and operational level, where it is seen only as a disturbance in the system which has been built up and is working. In the same way, a decision about a flow-directed organization may be seen as totally correct at the strategic and/or tactical level, but may be opposed at the operational level. It can also be seen as correct at the tactical and operational level, but be opposed at the strategic level, which is especially troublesome.

A proposal for reorganization always gives rise to parochial and status-conscious thinking. The problem is to avoid unnecessary difficulties in communication arising from

different planning horizons, departmental affiliations and professional backgrounds.

It is not easy to communicate; part of the problem is the creation of trust. Entirely open and free discussion, which is sometimes recommended, can be dangerous in this connection. The result may indeed be that the groups lose all confidence in the company, in other groups or in their own group and its assessments. This can destroy the very basis for continued collaboration and progress, and it is therefore in many cases better to define the problem area clearly and prescribe a frame of reference within which the various groups can then carry on discussions towards an acceptable solution. For this, it is necessary to have a detailed survey and communications analysis of the company, and this can then form the basis for working out problems and frames of reference.

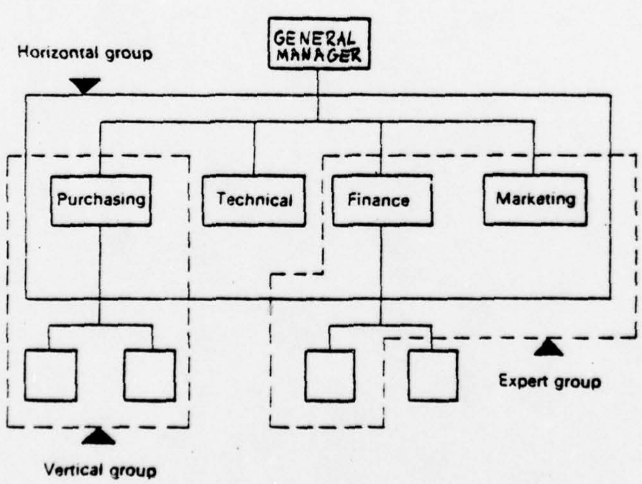


Figure 39. Examples of group formations in a company [6;160].

In the practical examples quoted, the theoretical background is set down in an attempt to combine in the most practical way the activities which "belong together"—here the logistics activities—and to develop the other functions similarly.

In AB Gulu we have taken account of the "expert groups" by developing a "commercial" group under the marketing manager, which is therefore responsible for both supplier and customer markets, and a technical group under the technical director.

Because the manufacturing, logistics, purchasing and marketing managers take the main share of the implementation, the directors' capacity for planning and development work is freed, and this is further strengthened by the broad functional connections with the development and the administration directors. The need to invest in development is emphasized, as we have a development department, again at a high level, whose task is, in collaboration with other functions, to be responsible for analysis of future, long-term planning and to translate its findings into action.

In AB Deric we also have a development manager at a high level and we have chosen to assemble the logistics activities under a manager who is directly responsible to the technical director. In this case we have attempted to solve communications problems by functional connection and increased work in project groups.

We have quoted two cases where integrated administration of supply, stores- and stockholding, manufacturing and distribution have given good results. There are, however, still many branches of industry which have not yet realized the opportunities which this approach gives.

Service companies, for example various types of transport companies, have in many cases a tendency to ignore logistics activities since they are selling not products but services. Analysis shows, however, that in many cases the problem is very like the problems which a production-oriented industrial company faces. In both cases, the problem is to maintain a production apparatus in top condition so that the time program can be held. If the logistics activities are split between too many hands, there is a tendency to "over insure," since everyone wishes to protect himself and install his own buffer against uncertainties. This leads to unnecessarily large stores and stocks of spare parts and the insurance premium becomes unnecessarily high.

There is no general organizational solution, and we must also remember that a solution can be technically correct but unacceptable for personality reasons.

H. LOGISTICS INFORMATION FLOW

Managements tend to perform only half a job in reorganization. They often lose sight of simple relationships between an organization-management structure and information needs. Many times they fail to follow up a reorganization with a reappraisal of the information system; thus managers are given

new responsibilities and decision making authorities, but do not receive all the information components required for effective performance.

Information is the trigger for subsequent flows of physical material in a logistics system. The sales forecast triggers production, transportation, warehousing and procurement activities. Customers, warehouse replenishment, and purchase orders set in motion various chains of events which culminate in the physical movement of goods. The speed, accuracy, and efficiency with which information flows are effected within a system have a large bearing on the performance of the entire LM system.

The overall organization and management framework facilitates the flow of information and makes appropriate decisions. In this vein, the communication systems appear paramount with the organizational structure around it as a framework. The term information-decision system highlights the point that the information developed should be formulated in light of the decisions to be made. Thus, it should be designed with the end use of both input and output elements of decision-making.

Information is used for planning, operating and controlling the overall logistics system. These uses provide us with a convenient framework for discussing the design of information flows. As shown in Figure 40, there are sharp contrasts in the nature of information and its use for logistics system planning, operation and control.

Characteristics of Information Use in Each Management Activity	System Planning	System Operation	System Control
Degree of aggregation of information	High	Low	Moderate
Importance of information external to the current logistics system	High	Low	Moderate
Currency of information	Low	High	Moderate
Frequency of information use	Low	High	Moderate
Relative cost in each management activity of:			
Data collection	60	25	30
Data communication	5	40	15
Data processing	30	30	35
Data distribution	5	5	20
	100	100	100

Figure 40. The nature of information, its uses, and its costs in various logistics management activities [8;500].

Planning as opposed to operating or control purposes, allows for greater aggregation of data. For example, in planning it may be sufficient to know the volume of material and the number of orders processed by a distribution center for a selected period of time. For operations, however, we must know the exact content of each order and its associated customer and shipping information. Effective control may require that we know the proportion of order-line items shipped late during a given period of time, perhaps by broad product categories.

Planning requires "external" information, the detailed assessment of alternative costs and technologies provided by organizations not currently parties to the logistics system being redesigned. Logistics operations require much less

external information, other than environmental information regarding possible interruptions in operations, such as weather conditions or impending strikes by labor. Again, control falls between these two activities in its needs for external information, relying on the continuing monitoring of such matters as competitors' customer service levels and changes in transportation services and costs.

The basis for logistics systems planning can vary from year-old data to forecasts of future needs. In contrast, certain types of operations may require instantaneous data availability and revision, while logistics control relies on weekly or monthly reports of operations, repeated only for selected activities not conforming to plan.

The emphasis of our discussion reflects the fact that formal logistics system planning of any magnitude occurs rather infrequently in most system organizations. The costs associated with such efforts are concentrated in data collection and processing as opposed to data communication and distribution. Much of the data-processing activity associated with planning involves manual preparation of data, often for eventual analysis by means of computer. But contrary to popular belief, computer costs, per se, are not a major item of expense in most well-designed system-planning efforts.

In contrast, system operation is an ongoing activity involving substantial costs for the communication of transaction data. The cost breakdown in Figure 40 assumes a centralized information-processing unit essentially trading

reductions in processing costs for increases in data communication costs. Order entry, the predominant data collection activity for logistics operations, may involve varying degrees of expense for manual labor as opposed to machine processing.

System control relies on periodic knowledge of system performance. Data distribution takes on greater importance in the costs of system control activities, reflecting the reliance of effective control primarily on the communication of selected operating information upward to policy making levels in the organization.

Over all, the development of the logistics organization and a logistics information system are mutually reinforcing actions.

A computer-based information system does not precede the establishment of a coordinative logistics group. However, the development of such information systems contributes dramatically to the growth of logistics as a coordinating concept within the total firm.

The planning of logistics information flows requires a determination of: (1) what each manager needs to know to carry out his job, (2) the objectives of speed and accuracy which the system is to achieve, (3) the volume of information which the system must process, and (4) the procedures, equipment, and manpower needed to meet managerial needs and objectives within specified cost limits.

Information is valuable to a logistics manager only if he "needs to know" about a particular aspect of his organization—its customers, its suppliers, or the techniques that can be employed to improve the operations for which he is responsible. He may be curious about many phases of activity with which he is not concerned, but he is probably well advised to become involved only with the information which is required for the operation of his department, or essential to effective communication with other departments within the firm or necessary to maintain sound relations with customers and suppliers.

This is not to suggest that a manager should bury his head in the sand of his own operational problems, but any manager who has been victimized by too much data of questionable value can testify that in many respects it is worse than not having enough data for management. This point is important, for many persons knowledgeable about the planning of information systems agree that the manager with operating responsibility is in a better position to specify his needs than is a centralized systems group. Thus, a manager responsible for the logistics function may have to help his subordinates in charge of traffic, warehousing, inventory control, and order processing determine their information needs as well. Further, he will participate in the process of determining what other managers in his own and other organizations need to know from him, a process which specifies logistics information flow both external and internal to the firm.

A variety of two-way flows of information between customers and their supplier firm are shown in Figure 41. While formal, often mechanized methods provide the conduit for the flow of operating information, in the form of customer orders or carrier "passing" (shipment progress) reports, the salesman may be a major source of logistical planning and control information. Figure 41 reflects the nature of information flows between a firm and its suppliers as well. Here the supplier's sales representative and the purchasing agent for the company may form the primary channel for external planning and control information.

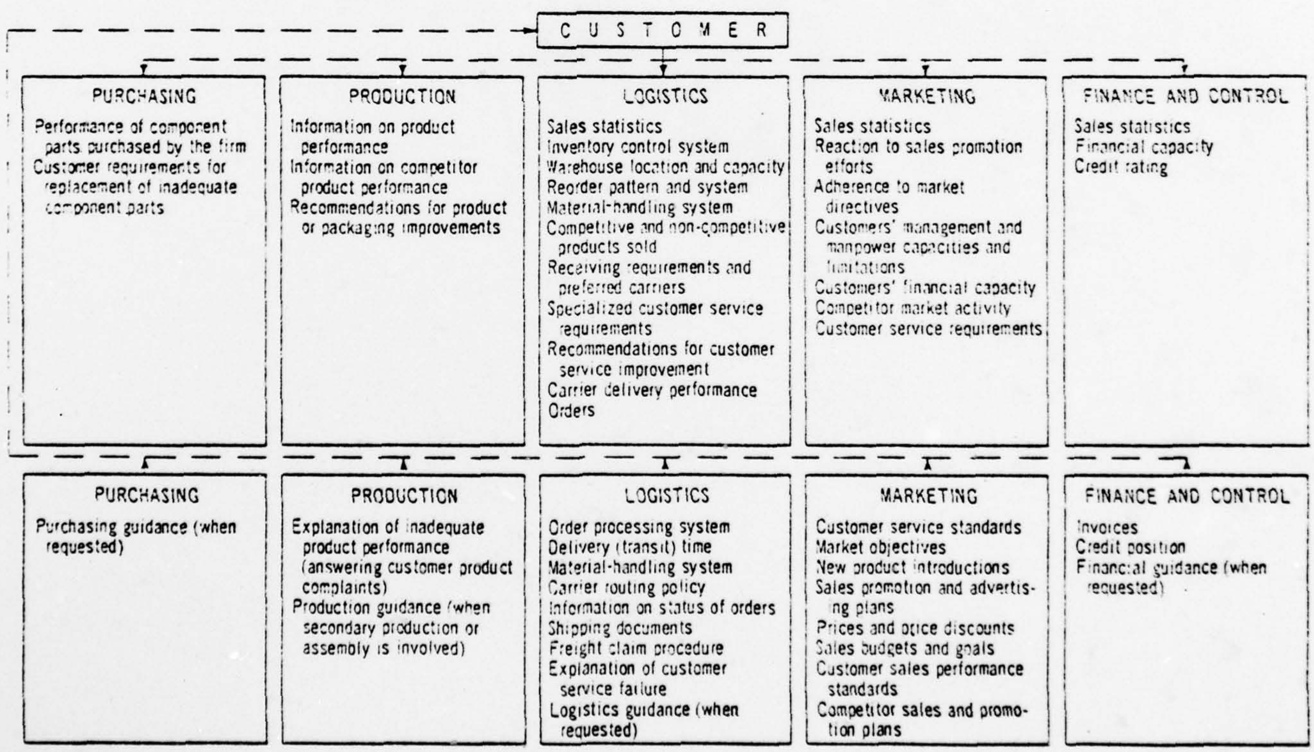


Figure 41. Examples of various types of external information flows between a firm and its customer [8;509].

Some internal information exchanges that are of value for logistics are illustrated in Figure 42. Naturally, these will be influenced by the assignment of responsibility and the nature of the organization for the management of logistics activities.

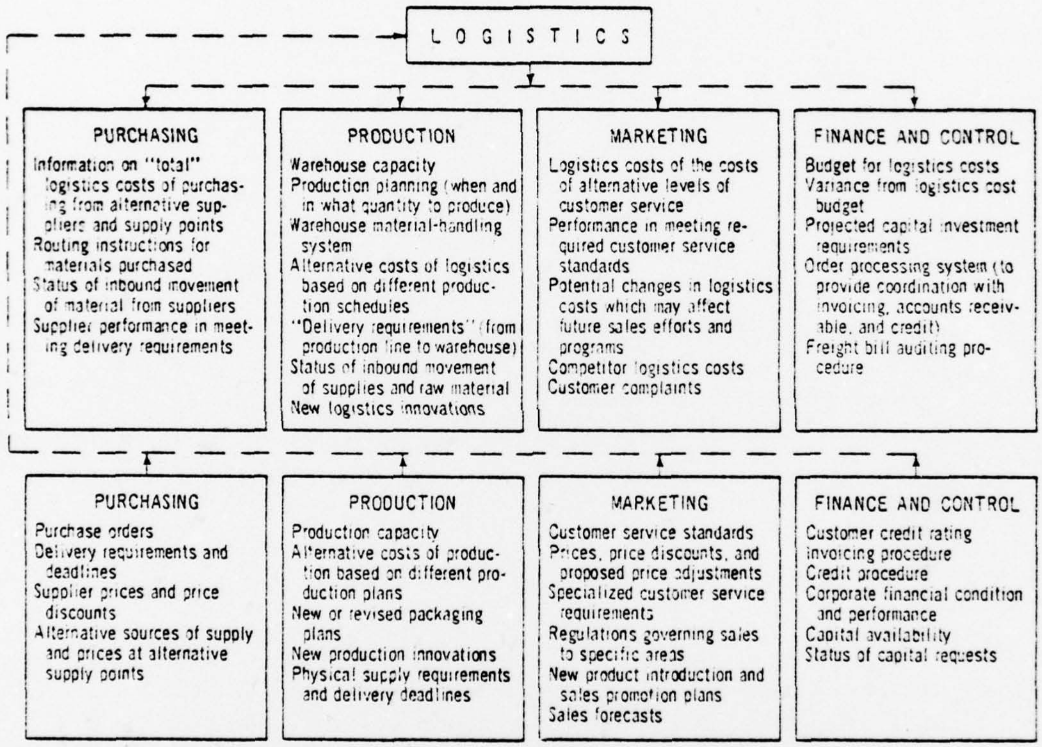


Figure 42. Examples of various types of internal information flows between the logistics function and its "sister" functions in a firm [8;511].

What we have shown in Figures 41 and 42 is a small portion of a logistics information system, the formal part. We must remember that people communicate informally, by telephone, conferences, or other means, much information that is not

contained in any of the written forms and reports. While we cannot discuss the psychology of personal or informal communications, we should emphasize that personal contact and a proper attitude toward it, is perhaps the most important element of a sound logistics information system.

Information for the operation of a logistics system passes through a series of stages as the order, replenishment, procurement, inventory update, billing, and payment cycles—all elements concerned with or initiated by order-processing activities. Because of its relatively routine nature and large volume in many organizations, such information lends itself to machine processing.

Order processing constitutes a significant portion of the time, and in some cases the cost, required in a logistics system. As such, it constitutes the link between information and physical flows, and the trading of costs between them. For example, a day saved in order-processing time may be as significant in reducing necessary inventories as a day saved in materials handling or transportation. And it may be much less costly to accomplish time savings in information as opposed to physical flows.

Because it is difficult to discuss order processing and logistics information operations in the abstract, two brief examples [8;516 and 520] may help to illustrate some of the comments made so far:

Westinghouse Electric Corporation. ("At Westinghouse," Traffic & Distribution Management, January, 1962.) An early,

forward-looking order-processing system was implemented by Westinghouse for its apparatus products group. It involved the collection of 1500 to 1600 orders daily by mail and telephone at more than 90 sales offices; a coding of the order with a six-digit, self-checking address number (with which a computer later could locate all customer information) and five-digit self-checking product numbers; typing of the coded information (averaging 55 characters per order plus special instructions) on five-channel paper teletypewriter tape; transmission by teletype to the company's centralized RAMAG (Random Access Method of Accounting and Control) computer facility; conversion to punched cards for input to the computer; computerized location of stock nearest to the customer, inventory updating, and preparation of punched cards from which invoices were prepared at headquarters; conversion of the cards to tape for teletype transmission; and teletype receipt of information at field warehouses and plants in the form of complete shipping orders, packing lists, labels, and the required number of copies of bills of lading.

At the time it was implemented, this system was credited with eliminating the two to four days an order spent previously in the mail and the two days required for its handling at the shipping point, thus reducing these portions of the order cycle by as much as six days by replacing them with a 30-minute process under ideal conditions. As a result: (1) inventories of one product line were reduced from $5 million to $2.7 million, (2) cash flow was improved by five

days, (3) faster delivery was accomplished for 15,000 customers, (4) several field warehouses were closed, (5) a large number of deliveries could be made directly from plants, (6) inventory accounting and control was computerized, and (7) sales tax, and financial accounting data were produced as a byproduct of the system.

This system made use of what, at the time, was the largest industrial teletype network of its kind in the world, including 230 sending stations and 243 receiving stations connected by 28,700 miles of duplex (simultaneous two-way transmission) lines feeding into two automatic switching units in Pittsburgh. In addition, it required four additional lines for the transmission of sales order information from the centralized order-processing department in Pittsburgh, adding another 5,263 miles of wire to the network.

An interesting footnote to the implementation of this (and other) real-time information-processing systems is the fact that Westinghouse reported that it had to synchronize working hours at its 26 field warehouses located in four time zones.

<u>Phillips Electric</u>. ("Telecomputing from Ordering to Forwarding." Company document)

This large European-based manufacturer of a wide range of consumer and industrial electrical products recently has developed a logistics information system called ORFO (ORdering to FOrwarding) for its Lighting Division. ORFO is implemented on a modular, step-by-step basis. Its capabilities for linking

50 National Organizations (N. O.'s, consisting of sales offices and order-receiving points in various countries) with the company's six factories, its Eurostore facility (central distribution center), and its Eindhoven headquarters, all in the Netherlands, include the following:

1. Transfer of orders electronically from most European N. O.'s to the central computer facility at Eindhoven.
2. Hourly processing of such information.
3. Issuance of instructions, also according to a schedule, to the Eurostore for preparing ordered items for shipment.
4. Preparation of both the invoice and the appropriate international shipping documents by computer.
5. Handling of international accounting and statistics associated with the flow of material.
6. Capability for guiding internal production planning, inventory control, and even Eurostore stock location selections.

Two additional features of this system are that it files orders with distant requested delivery dates until the appropriate time, and it reviews shipments from plants to the Eurostore to identify merchandise that can be shipped to customers without first being moved into the Eurostore stocks.

This system reduces order-processing times by 80%. Now that this is accomplished, "delaying factors in physical goods handling and transportation facilities will get emphasized attention."

The logistician may develop both informal and formal ways of acquiring the information that he needs. These range from information exchanged over cocktails to well-established procedures for data collection. Since the computer has become an integral part of business operations, there has been a trend toward more formal and highly structured information systems. The capacity of the computer for data storage and manipulation is increasingly making it more central to information system design. However, this is not suggesting that every information system should be computer-oriented, but the computer has unquestionably expanded the manager's information base.

The logistics information system, whether computer oriented or not, is shown in Figure 43.

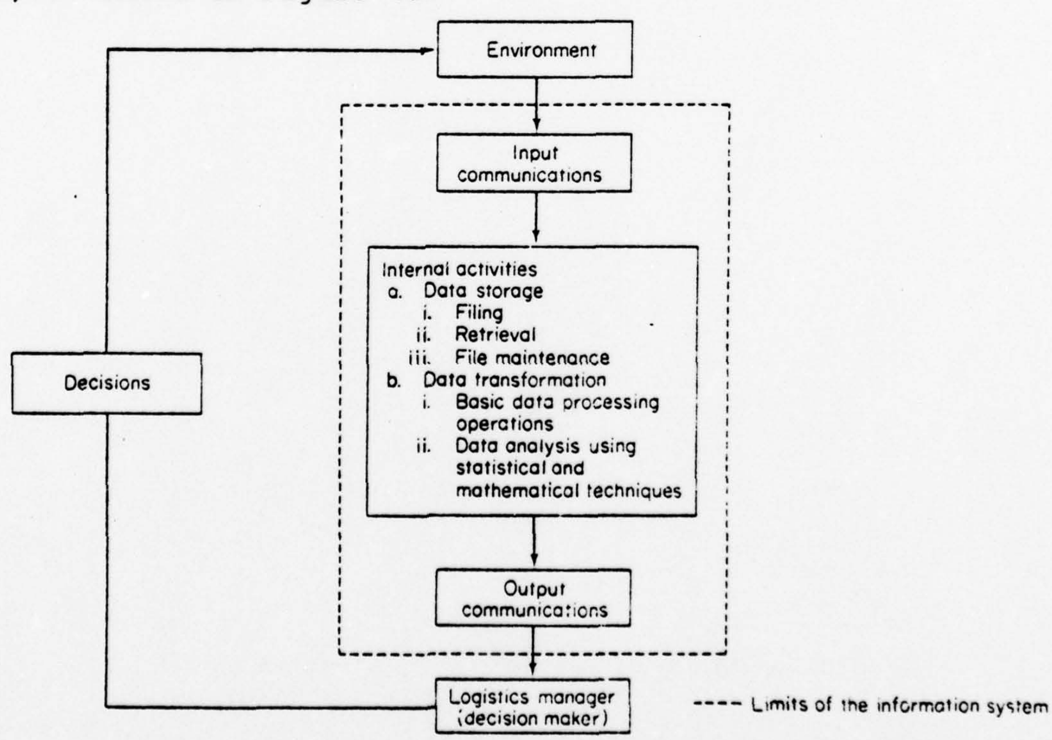


Figure 43. Elements of logistics information system and the relationship to the environment and decision maker [7;57].

Three primary activities take place within the system: (1) the communication of input data, (2) the processing and storage of input data, and (3) the communication of the data from storage or after it has been processed. The logistics information system described herein might better be referred to as a decision information system. It is broader in scope than an order-processing system that emphasizes data collection, storage and report functions—basic data processing activities.

The logistics information system includes various models developed to assist in evaluating logistics system design alternatives as well as standard statistical routines for manipulating data. Order processing, which often is treated as synonymous with logistics information system, is only one aspect of the total system. The decision system within information systems decomposes into two types. The first includes mathematical and statistical models that facilitate analysis of data. This system does not make final decisions and does not initiate any action. It is referred to as a decision-assisting system. The second type is referred to as a control system. It is similar to the first, except that the decision loop is closed within the system. That is, based on preestablished decision rules, the system will respond to data from the environment and initiate some action. Computerized inventory control systems and computer-controlled materials handling and storage in warehouses are examples.

Control systems com[illegible]ed with decision-assisting systems create a distinct danger for the manager that should be recognized. The manager delegates a certain amount of his decision-making responsibility to a set of rules and procedures. Along with this, he may also lose direct control over the decision activity and ultimately control over the efficiency with which the activity is carried on. Loss of control over computerized inventory control systems offers far too frequent an example of this. Hence, when an information system includes control systems, positive steps need to be taken to prevent managerial loss of control.

The information system in logistics is a subset of the total information system for the firm. It is the focal point within the firm for information that is relevant to logistics decision making. Broadly, it is a data translator, transmitter, and storage system that gives form, time, and place values to information, and may also act as a decision maker when programmed as a control system. It serves as more than a data bank or an order-processing system. It also aids in analysis of data through the use of statistical and mathematical models. Information systems may be designed on three levels: (1) a basic data processing level where little analysis takes place, (2) a level where statistical and mathematical models become an integral and useful part of the system for data analysis but no action takes place, and (3) a level where data analysis, decisions, and the logistics manager should be extremely careful about abdicating managerial

responsibility for decision making to the information system without establishing adequate controls over the system.

The significance of this discussion lies not only in the importance of logistics information systems to the functioning of an organization, it is of basic importance to the further development of effective logistics management.

I. PERFORMANCE MEASUREMENT AND CONTROL

While the theoretical base of reorganization behind logistics management is relatively well established, few performance measures—the real crux of effectiveness—have been developed.

Performance measurement and control are concepts as undeniable as "safety" in the minds of most managers. But few organizations implement them with any degree of effectiveness. The individual attitude often expressed about them is, "Performance measurement and control are, of course, extremely important for the company. But, unfortunately, my job is one for which performance measures are awfully hard to establish."

Regardless of the difficulty of devising and implementing a performance measurement and control program, it is especially essential for a function such as logistics.

The relationship between planning and performance measurement and control is one of a closed loop, the nature of which is suggested by the diagram in Figure 44. The plan should include both a set of goals and limits around those goals which represent the bounds of acceptable performance. Periodic performance measures will determine the relationship between planned and actual performance. Where the differences

between planned and actual performance levels are unacceptably large, an exception report or review audit will call the fact to the attention of management for appropriate action. The cumulative effect of such exception reports will influence the future planning effort to the extent that it points out flaws in past efforts to be avoided, or provided for, in future plans.

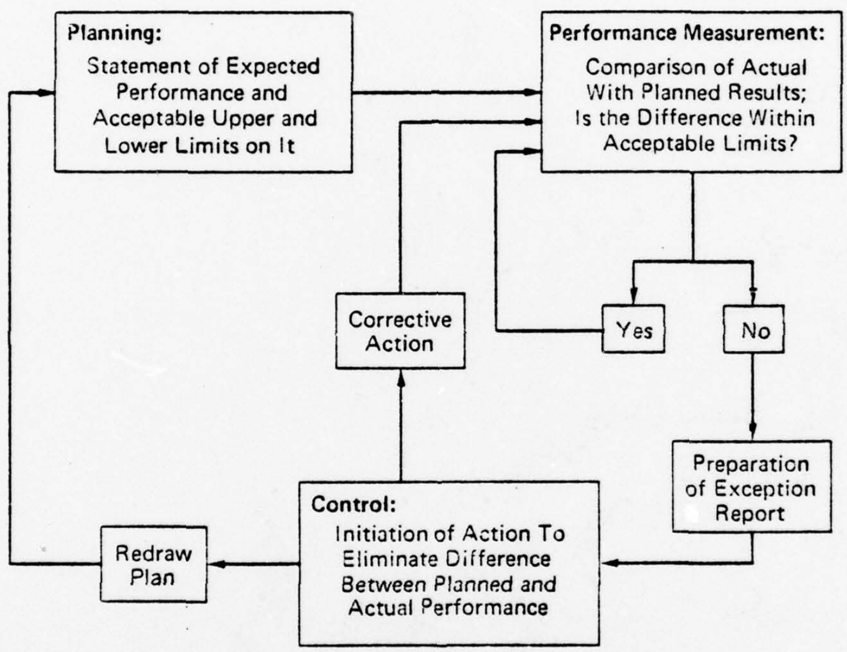


Figure 44. Relationship between planning and performance measurement and control in the management process [8;698].

The subheadings in this section form a checklist which can be used to spot-check the usefulness of a logistics performance measurement and control program. It is an effort to point up in a positive manner certain shortcomings in existing programs.

Emphasis on productivity rather than production. Production measures, signifying amounts of output, are of value for control purposes if the sole objective of such production is output. They provide a very limited frame of reference for evaluating output figures, even when there are successive output measurements over time with which to establish trends. In contrast, productivity measures relate outputs to inputs. The resulting ratios provide indicators of what must be paid for outputs in terms of time, costs or other inputs. As a result, they are often more useful than production measures.

Proper identification of cost inputs. Functional cost accounting, which identifies costs in such a way that they can be attributed to logistics, production, and marketing activities, is an art that is not only lost, but is yet to be found in many organizations. Once lost, functional costs have to be reconstructed by allocating categories of costs in "natural" accounts, such as labor or materials, on the basis of activity measurements, use of space, or some other assumed relationship between levels of activities and costs.

Balance in cost inputs reported. There is a further dichotomy in the identification of costs between explicit logistics costs such as purchased transportation and public warehousing costs, for which documentation is readily available, and implicit logistics costs, such as inventory carrying and internal handling costs, for which documentation is not naturally accumulated.

Effective cost allocation. Costs must be allocated in those cases in which they are not, or cannot be, accumulated in a manner that identifies costs by causes, profit centers, or functions. Typically, they are known as indirect costs. The less definite a cost collection and accounting system, the greater the proportion of costs that requires allocation.

There are 2 basic stages in the logistics cost allocation effort:

1. Allocating costs in natural accounts to functional accounts.

2. Assigning logistics costs, once identified, to cost responsibility centers.

Separation of controllable and non-controllable measures of inputs and outputs. "All costs are controllable by someone." This concept refers to the level of management that is responsible for the approval of the expenditure ...... But all costs are not controllable to the same degree.

Because managers are most effectively judged primarily by the way in which they manage controllable elements of their business, it is important to identify the controllable elements and report them separately, or at least to establish performance measures on elements that largely are controllable.

Once identified, controllable costs or other inputs can be compared with units of output on some logical basis. Naturally, every attempt should be made to relate outputs to these inputs from which they result. The relationship never will be perfect, but the goal is to achieve as much logical explanation as possible.

For measure of the effectiveness of all inputs, including those of capital, it can be useful occasionally to compare gross overall outputs with both controllable and non-controllable inputs.

Identification of productivity relationships. Experience gained in the collection of costs and other information will provide the basis on which to estimate the way in which productivity measures should vary, for example, in relation to changes in the volume of an organization's activity or in relation to one another.

Recognition of the impact of a control program on managerial behavior. A control program influences managerial behavior. When performance measures, goals, and review and reward procedures are established in such a way that different functions of an organization work at cross purposes, they may be less desirable than none at all.

The identification of cost relationships, either within or between separate managerial groups in an organization, should lead eventually to coordinated planning and performance measurement. Coordinated planning of interfunctional strategies can in turn encourage the establishment of goals that create a minimum of conflict among production, marketing, finance, and logistics management. This is a characteristic of a well conceived, well implemented program of planning and control.

Although many organizations are working toward such coordinated planning, all but a handful are still establishing

performance goals and measuring performance without regard for underlying implications of interfunctional strategies determined at the top level.

An illustrative situation is diagrammed in Figure 45, where production, marketing, and finance functions, in the absence of a coordinating group such as logistics, all have a deep and somewhat conflicting interest in inventory policy.

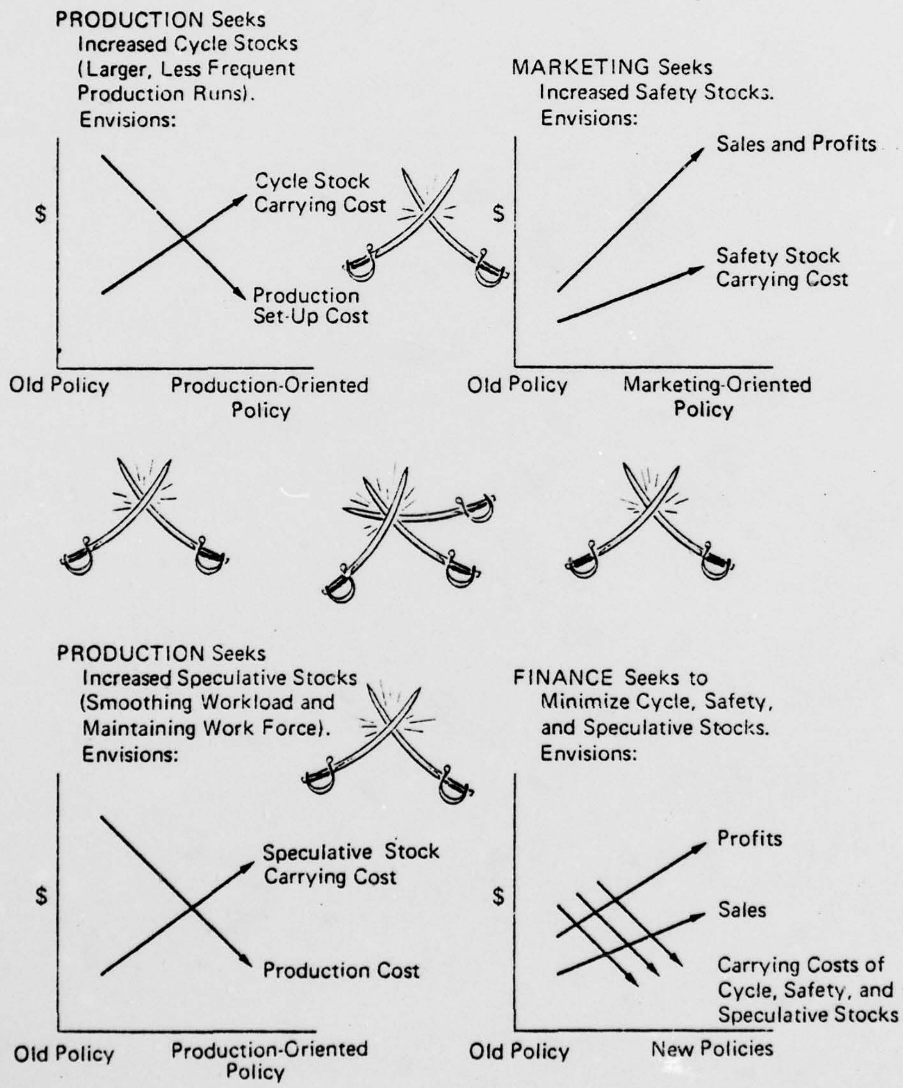


Figure 45. Basic conflicts in determining the amount and type of inventory to plan for, illustrating the need for the identification of cost (and profit) relationships and coordinated planning for logistics [11;16].

Unless the result of an inventory policy decision can be estimated, in terms of its impact on production set-up costs, per-unit production costs, inventory carrying costs and sales, it will be impossible to select a policy that will produce the best total result for the company as a whole. The degree to which such a policy creates an uncontrollable element in the performance of production, marketing, and financial management will go unmeasured in the concurrent establishment of performance goals for each.

Performance measurement of LM functions (purchasing, inventory control, production control and traffic are most common) could for example cover:

Purchasing:

1. A quantitative measure of idle machine and/or personnel resulting from a lack of purchased supplies.
2. A measure of the extent of successful substitutes of materials and parts.
3. Ratios of total purchasing salaries and expenses to total purchases and total manufacturing salaries and expenses.
4. The value of purchase orders subjected to competitive bidding, as a percentage of total orders placed.
5. Number of rush orders.
6. Quantitative measures of expediting expenses.
7. Ratio of rejected purchases to total purchases.

8. Savings on discounts and quantity purchases.

9. Measure of the extent of supplier technical assistance.

10. Measure of vendors keeping delivery promises.

<u>Inventory control (inventory of raw materials, goods-in process and finished goods)</u>:

1. Ratio of inventory investment to sales (by products).

2. Inventory turnover ratios for raw materials, goods-in-process and finished goods inventory.

3. Relationships of direct materials cost to finished goods.

4. Changes in "make or buy" dollars (dollars of this year's purchases which were "make" last year and vice-versa).

5. Performance in establishing reorder points, i.e., predetermined inventory levels at which additional purchases or production should be instituted.

6. The utilization of economic order quantities.

7. Cost of inventory operation as a percent of manufacturing costs and sales.

8. Actual costs versus budgeted costs.

9. Number of stockouts in the current year versus in the previous year.

10. Unit cost in the current year versus in the previous year.

Production planning and control:

1. Percentages of promises kept:
    a. Of customer shipments
    b. Shipments to finished stock
    c. Shop operations
2. Establishment of a direct materials price index, using an appropriate base year showing changes in internal and production costs.
3. Changes in "make or buy" (dollars of this year's "make" which were "buy" last year).
4. Amount of dollars of indirect materials and reductions.
5. Ratio of production planning and control salaries and expenses.
6. Changes in the average production cycle time for representative models or products (including new models, standard models, and repairs), etc.

Traffic (in- and outbound):

1. Ratio of the cost of inbound freight to total purchases.
2. Packaging costs, expressed as a percentage of hundred weight of shipments.
3. The use of outbound freight costs as a percent of sales.
4. Trend of total transportation costs.
5. Cost reduction.

6. Measure of average intransit time of incoming and outgoing shipments.
7. Claims as a percentage of freight costs.
8. Savings secured through rate adjustments.
9. Ratio of total traffic expenses to value of shipments.
10. Ratios of traffic salaries and expenses to total manufacturing salaries and expenses.

Measures which have been established successfully, with adaptions, in several logistics organizations are shown in Figure 46. The set of measures which can be applied to a company's overall logistics activity reflect here the scope and nature of logistics operations for a specific company:

Company: National Radiator Corp.

Period: March

System-Wide Report

	This Month	Last Month	This Month Last Year	Goal
Transportation:				
Plant to warehouses, cost per cwt.	$ .79	$ .81	$ .78	$ .78
Plant to customers, cost per cwt.	$ 1.67	$ 1.63	$ 1.60	$ 1.62
Field warehouse to customers, cost per cwt.	$ 1.43	$ 1.49	$ 1.47	$ 1.47
Between warehouses, cost per cwt., shipped from plant	$ .08	$ .04	$ .03	$ .03
Warehousing:				
Plant warehouse, cost per case handled out	$ .14	$ .14	$ .13	$ .14
Field warehouses, cost per case handled in and out	$ .53	$ .55	$ .55	$ .55
Plant, storage cost per case in average (annualized) inventory	$ .25	$ .22	$ .21	$ .21
Field warehouses, storage cost per case in average inventory	$ .30	$ .26	$ .27	$ .26
Inventory Control:				
Inventory turn, plant and field warehouses, on annualized basis	7.3	6.6	6.6	6.6
Values of total average inventory at cost (in millions)	$ 8.92	$10.02	$ 9.42	$ 9.50
Order Entry/Processing:				
Cost per order processed at plant	$ 9.90	$ 9.60	$ 9.50	$ 9.50
Cost per order processed at field warehouse	$12.30	$11.25	$11.45	$11.40
Customer Service:				
Percentage of line-item fill, field warehouse	86%	92%	89%	90%
Percentage of order fill, field warehouse	63%	75%	74%	75%
Air freight transport cost as percentage of warehouse-to-customer transport cost	3.2%	1.6%	1.5%	1.5%
Total Distribution Cost:				
Per case shipped to customers	$ 1.08	$ 1.02	$ 1.01	$ 1.00
As a percentage of sales	13.5%	12.7%	12.6%	12.5%

Figure 46. Report on performance in physical distribution according to given set of measures [8;700].

Performance measurement and control programs can be developed for ongoing logistics activities in a company, or be developed together with logistics projects involving redesign of all or some aspects of a logistics system. Such a program for evaluation of logistical performance would basically and principally be the same whether it is developed as a single program or as a part of a larger project.

The possible steps in the establishment of a logistics management control program might seem formidable. Sometimes the gap between ideal and actual is so great that we are discouraged from taking the first steps to bridge it. And yet the payoff, in terms of increased recognition for the importance of logistics activities within an organization and the individuals responsible for them, is so great that it is important to take the first steps toward the creation of such a program:

1. First, identify all important logistics cost categories along with inputs of efforts which the organization incurs. At this stage, the objective is to be complete.

2. Begin collecting the cost and input data. At first, this might be done on a one-short basis, for example, for the preceding year. Later, of course, the objective is to have such reporting carried out on a periodic, routine basis.

3. Identify and begin collecting important output measures. Production measures may be more easily obtained than those of input.

4. Prepare a set of desired measures by which the LM activities within the organization might be evaluated. Such measures should encompass all logistics activities, regardless of the assignment of responsibility for them. They might reflect the scope of those in Figure 46, including various measures for transportation, warehousing, inventory control, order entry and processing, customer service, and total logistics cost performance.

5. These measures can then be presented to top management, along with an estimate of the importance of the logistice costs which have been collected in step 2.

6. Assuming top management's support, a program to report regularly productivity measures such as those presented in Figure 46 can be instituted. In all likelihood, even at this stage, sufficient information required for all of these measures will not be available on a regular basis.

7. Assuming support for the program is continued, organizations will develop a need for someone in the accounting or controller's function to serve as liaison between those departments and individuals responsible for logistics activities. This will facilitate the regular collection and reporting of necessary information. In most cases, this effort will require that monetary and physical measures of activity be recorded and coded at the point at which they are captured for entry into the company's management information system, a basic escalation in effort requiring a policy commitment as well as the investment of funds sufficient to support the activity.

8. As productivity measures for budgeting and performance measurement and review purposes are collected, involved executives will begin to develop a "feel" for interrelationships among various types of outputs, inputs, and measures and goals developed for sister departments within the organization. Not until this stage of development is reached can an organization develop the type of coordinated planning that will correct the situation described in Figure 45. The stage will be set for the development of interfunctional planning teams to help in the preparation of budget and performance goals which take into account and attempt to reduce the magnitude of goal conflicts so common to production, marketing, finance, and logistics management.

9. The development of a coordinated program for performance and control also will facilitate more sophisticated efforts, such as those to plan and control particular LM projects and to measure the relative profitability of various types of business activity.

In contrast to the requirements for performance measurement and control programs are controls of projects throughout the iterative process from feasibility to successful implementation. Here budgets and time schedules for each stage must be estimated, and the commitment of the responsible executive obtained.

Reference Figure 44 and previous sections in this chapter about analyzing and planning for LM system and the development life cycle.

Network scheduling and Gantt charts can aid the scheduling and the exercise of control on the critical path. Performance measures of systems development work will tend to be in terms of meeting target dates with viable, required systems, within the agreed budget.

A project steering committee can provide a means of motivation, communication and the exercise of managerial oversight. It can also ensure that system developments are in phase with the overall systems strategy.

The subsequent appraisal of the completed project, to see if the required objectives have been met and to feedback costs and benefits to compare with the original plans, is vital for management control: yet, it is often overlooked. Any discrepancies between expectations and actual results provide control information for subsequent adjustment to the system to achieve the objectives or a learning experience where the original plan was not feasible. Periodic management audits of the system resources can also be made to assess effectiveness to establish, perhaps on a MBO (Management by Objectives) basis, activities that can be improved.

Finally, management consideration should be given to changes that inevitably occur in systems as new output requirements arise, input is varied, volumes and peaks change, unforeseen circumstances occur or new equipment or software becomes available. Such changes may apparently need no more than a relatively small program amendment "boot-strapped" onto the existing programs; in reality, managerial questions of

system costs/benefits, security, systems controls and audit checks can arise. In a sophisticated computer-based system, technical and managerial time must be devoted to systems maintenance, and clear documentation is essential.

J. REVIEW

We have considered here the design of a LM system for planning the physical flows of goods and flows of logistics information operating the system and controlling the operation of the logistics activities. The significance of this discussion lies not only in the importance of the LM system to the functioning of an organizaion. It is also of basic importance to the further development of effective logistics management.

What distinguishes a comprehensive logistics system design effort from others? First, most likely it will concern itself with activities and costs of both movement and demand-supply coordination. Through total cost analysis, it emphasizes the appraisal of all costs of transportation, warehousing, packaging and material handling, order processing, inventory holding, and procurement resulting from a decision to utilize a particular method of accomplishing each activity. Further, it focuses on the analysis of the nature of change in these costs under varying conditions. Typically, such changes involve cost trade-offs.

Second, comprehensive logistics system design involves the use of people, machines, materials, and information in such a way that the parts are closely integrated to create

greater productivity in the system than that suggested by the sum of its components. The concurrent design of a logistics component is rarely possible because of previous commitments and heavy and perhaps mistaken emphasis on sunk costs. However, this second identifying characteristic emphasizes, to the extent possible, the avoidance of sub-optimization of system components (the optimization of one system component to the detriment of total system cost or performance). To do this requires a systematic approach to the analysis and planning of a logistics system. Such an approach should also be flexible enough to meet individual exigencies.

Third, a comprehensive design often views the movement of goods and the coordination of demand and supply not necessarily only as activities carried on by or for one firm, but by and for firms at two or more levels in a channel of logistics. It recognizes that the price of a product to an ultimate consumer includes the costs of the sum of a number of logistics operations repeated over and over in a channel of distribution.

Logistical plans may be made and implemented but that alone does not ensure accomplishment of the goals around which the plans were developed. It is necessary to think in terms of a fourth primary function in addition to definition, design and implementation. This fourth function is control, which may be defined as the process where planned performance is brought into line or kept in line with desired objectives. The control process is one of comparing actual performance to

planned performance and initiating corrective action to bring the two more closely together, if required. Control is action by exception.

The principle of management by exception keeps the manager away from routine operations and allows him to manage the overall operation. His attention is needed only when consequential problems arise. Within the design of a LM system the framework of management indicators or red warning lights must be identified and included in the system. Indicators should be able to be monitored quickly and they should allow enough time for remedial action. For example, the following are indicators which may be used for inventory control activity:

* Customer satisfaction falls below 90%
* Zero balance lines above 10%
* Warehouse denials above 2%
* Order-processing time is in excess of 3 days
* Materials handling equipment deadline rate over 10%.

All exception reports and indicators must be enumerated from the start. These requirements are met when designing the output data for the new LM system.

The principal success with adoption of the logistics management concept are mainly improved distribution control, improved inventory management, decreased purchasing costs, more effective communication paths, better supplier/customer cooperation, and overall improved efficiency in logistics subfunctions.

IV. CONCLUSION

A. RECAPITULATION

Logistics in an organization encompasses activities with both materials management (for inbound raw materials, supplies, components, and products purchased for resale) and physical distribution (for outbound components and finished products, for example).

The field of logistics management has evolved from specific ideas which can be traced back in the literature at least as far as the nineteenth century, and in more general sense back to the earliest recordings of man. However, forces emerging since World War II have greatly accelerated the emphasis on logistics as the last major neglected area of management. Among such forces are rising costs, the development of new analytical techniques and computing equipment, the increasing physical complexity of business operations and organizations, the expanding range of methods for transporting and handling materials, changes in the marketplace and in channels of distribution through which goods move, the shifting of responsibilities within such channels, and the pressures created by the widespread adoption of the marketing concept, or a marketing-oriented approach to business.

Costs form an important part of the decision process for logistics management. They vary widely in importance from industry to industry as firms attempt to balance basic costs

of transportation and inventory maintenance in such a way that a relatively low total cost results. The relative importance of these costs will depend on such factors as the physical characteristics of the product, management policies which consider logistics in relation to other major cost categories or service objectives, the geographic location of a company's facilities in relation to its supply sources and markets, and the role that the firm in question may play in a channel of distribution.

The basic source of problems and opportunities in the organization for the management of logistics activities can be traced to the fact that logistics management deals with horizontal flows of material and information which do not lend themselves to compartmentalization in the form implied by the typical vertical or functional organization structure. An analysis on which organizational change can be based will take into account the importance of logistics activities in the organization, the establishment of the need for reorganization, the identification of activities for which common logistics management is most important, and consideration of alternative approaches to providing necessary communication and coordination of the activities.

The appropriate organizational position for logistics management will depend primarily on the relative emphasis placed on cost control or service performance as a basic objective for logistics operations. Regardless of his responsibilities, a logistics manager in most organizations,

to be successful, must play the role and possess the qualities of an integrator.

The system development approach is used as a basis/guideline for the design of a logistics management system.

In designing the LM system, we must take account of a number of external and internal restraints. Examples of external restraints are the competitive system, the transport system, laws and regulations. The projected level of service, existing resources and competitive policy are examples of internal factors which must be taken into account when the system is being designed.

The stages in the solution of the problem can be summarized as follows:

* definition of the system
* formulation of objectives
* establishing what restraints exist
* assembly of information and trade-off qualifications
* design of a system
* application and follow-up.

These stages are not, of course, separate in time but interact strongly and depend on each other.

The logistics information system is a subset of the total information system for the firm. It is the focal point within the firm for information that is relevant to logistics decision making.

Since logistics management is first of all concerned with flows of material and associated information through the firm,

the information system becomes just as important as the material system.

The speed, accuracy, and efficiency with which information flows are effected within a system have a large bearing on the performance of the entire logistics system.

Logistics control helps to ensure that the goals around which logistics plans were developed are achieved after the plan is put into action. The dynamics and uncertainties of the logistics environment over time can cause deviations from planned process performance. To keep process performance in line with desired performance objectives, some form of managerial control is required.

The control process is one of comparing actual performance to planned performance and initiating corrective action to bring the two more closely together, when necessary. Control is action by exception.

A complete logistics management system consists of the following major parts: a material subsystem, an information subsystem, a control subsystem and an organizational structure. None of these parts can be viewed separately since they cannot function alone. They can only be evaluated as one system made up by four interdependent and interactive major parts.

The LM approach can put the total logistics system at the center and will aim at setting "under one hat" as much as possible of the authority for decision along this flow. There is no doubt whatever that improved control and review

of the logistics flow should be able to contribute significantly to increased profitability.

B. CONCLUDING COMMENTS

Logistics management offers a modern, integrated approach to the control and physical movement of raw materials, components and finished goods from the supplier through the manufacturer and distributor to the ultimate user:

Among the benefits are:

* improved distribution control
* improved inventory management
* decreased purchasing costs
* more effective communication paths
* better supplier/customer cooperation.

To produce maximum efficiency from the LM approach:

* The logistics activities within a company must be coordinated, for example, in a logistics department.
* The functions within a company must be coordinated, for example through company planning and the work of project groups.
* Companies within a distribution channel must be coordinated, for example by annual agreements, coplanning or subcontractor systems.
* Companies must adapt themselves to the demands and expectations of the external environment.

It should be clear that the efficiency of the logistics system is maximized by means of far-reaching coordination and coplanning of the components which compose it, and in this

way the whole channel is comprehended as a unit. How far this is worth the effort, or even possible, can be decided only by the decision makers themselves during the analysis of an actual situation.

Integration of the vertical subsystem moreover causes disturbances in the horizontal competitive system and makes competition on the same terms difficult. In the long run, this can affect efficiency adversely. Thus, when we extend our efforts at integration to embracing external logistics systems as well, we must accurately analyze and assess the long-term effects of this before we make decisions.

The application of the integrated approach to the management of functionally related areas goes beyond the logistics function. It demonstrates the possibilities of breaking down, with rational, reasonable control, departmental boundaries which had long existed in the company. The growth of logistics management as a development of the systems approach to company control runs parallel with the increase in computer-oriented thinking in a large part of industry. As long as the control of logistics begins with the requisitioning of purchases and finishes with the delivery to the customer, the systems approach which is most suitable and logical will be LM.

LM is especially applicable when:

* logistics costs make up a large part of total costs.
* the company has complex and diversified product lines.
* the company has a decentralized structure.

As a final conclusion, it can be said that even though LM is functionally defined, its special organizational form is not at all as uniform as is the acceptance of the LM concept. Companies organize themselves in conformity with their own specific requirements. LM is more of a concept than an organizational form. The number of LM companies has grown rapidly in the last few years and can be foreseen as continuing to grow rapidly in the future.

C. A LOOK TO THE FUTURE

The past twenty years have produced remarkable technological advances in transportation, material handling, and information processing.

Partly in response to technological change, most industrial and commercial companies have reorganized to improve the management of logistics activities and make intelligent use of the newly available technology. Increased breadth, both in terms of the backgrounds of individuals attracted to the field and the scope of responsibilities which they have been given, has facilitated a trend toward the purchase of carrier services, physical facilities, and logistics system equipment as elements in a broader system of related activities. The widespread use of computer technology for operational control of logistics activities has freed time for a greater amount of appraisal of strategic alternatives on the part of logistics management. In this sense, the last 10 years can fairly be termed an era of organizational as well as technological change in logistics.

If we have witnessed significant technological and organizational change in the recent past, what does the foreseeable future hold? Will new technology continue to provide the primary means with which to deal with problems arising from these and other trends?

There are signs that suggest that the answer to the last question is "no." While technological and organizational change will, of course, continue, the headlines during the next 10 years will be made by institutional changes—those involving the spatial reordering of functions and facilities within an organization and between cooperating organizations. This represents a logical progression in logistics management from emphasis on decision making based on internal total cost analysis to emphasis on internal total profit analysis and interorganizational total cost and profit analysis of the sort suggested in Figure 47.

Continued organizational development for logistics management will provide further support for institutional change to the extent that it will foster: (1) continued emphasis on the LM system (including related services provided by other companies) as the appropriate unit for analysis, redesign, and control, (2) the development of information necessary for the appraisal of new institutional arrangements, and (3) the development of a cadre of managers capable of analyzing and dealing with interorganizational problems.

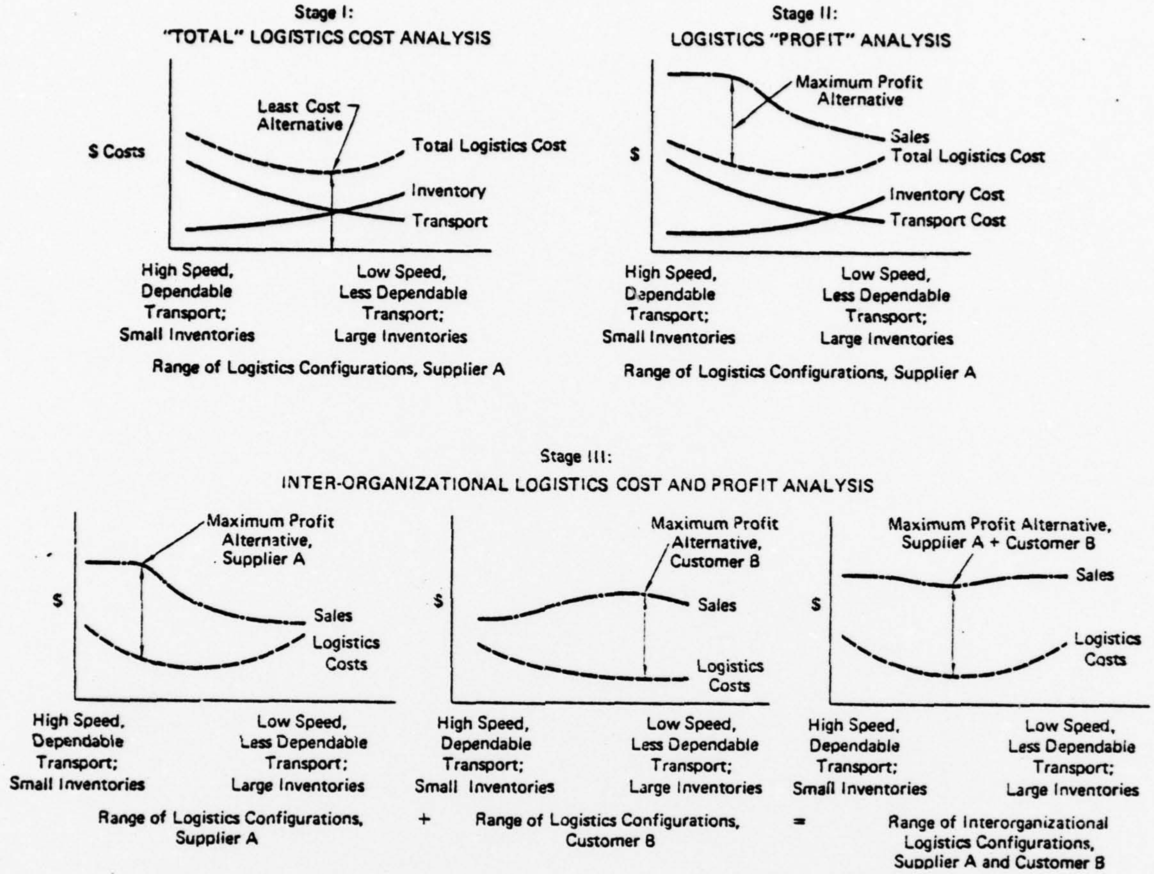


Figure 47. Stages in the scope of analysis for logistics decision making [8;736].

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